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THERMAL CONDUCTIVITY STANDARD REFERENCE

MATERIALS FROM 4 TO 300K. I. ARMCO IRON

by

J. G. Hust

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THERMAL CONDUCTIVITY STANDARD REFERENCE
MATERIALS FROM 4 to 300 K. I. ARMCO IRON*

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ABSTRACT

Thermal conductivity, electrical resistivity, Lorenz ratio, and thermopower data are reported for several specimens of Armco iron for temperatures from 4 to 300 K. At low temperatures the electrical resistivity and thermal conductivity vary from specimen to specimen by more than 10%. However, the Lorenz ratios of these specimens differ by less than 1.5%; and the intrinsic resistivities calculated using Matthiessen's rule differ by less than 0.2% of the total resistivities. Thus, Armco iron specimens can be used as standards by measuring the residual resistivities and utilizing the Lorenz ratio reported here.

KEY WORDS

Cryogenics, electrical resistivity, iron, Lorenz ratio, Seebeck effect, thermal conductivity, transport properties.

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1. Introduction

Design and development engineers in the aerospace industry continue to have urgent need for thermal and mechanical property data for new materials. For most materials, especially new or uncommon alloys measured values of thermal conductivity are not available and predictions cannot be made with adequate confidence. To help satisfy these needs, we have constructed an apparatus for the simultaneous measurement of thermal conductivity, electrical resistivity and thermopower. Measurements have been conducted on several aerospace alloys, Hust, et al.^[1] Another phase of this program, to establish standard reference data on several standard reference materials (or specimens), has begun. We intend to measure several specimens of materials which appear to be useful as standards. For some materials, material variability may be so great that only standard specimens (not standard materials) will be useful. Standard reference specimens or materials are useful for intercomparison of existing apparatus, for debugging new apparatus, and for calibration of comparative apparatus. The apparent large differences between the results of various investigators for a given material (50% is not unheard of) is evidence of the need for intercomparisons, calibrations, and standardization. The availability of standard reference materials will result in more accurate and more permanent transport property data for technically important solids.

This paper contains the results of our measurements on the transport properties of Armco iron.* Armco iron was investigated at low temperatures primarily because of its extensive use as a thermal conductivity standard at higher temperatures.^[2]

* The use in this paper of trade names of specific products is essential to the proper understanding of the work presented. Their use in no way implies any approval, endorsement, or recommendations by NBS. Armco iron is a registered trade name of a commercially pure iron produced by Armco Steel Corporation.

2. Apparatus and Data Analysis

The apparatus is based on the axial one-dimensional heat flow method. The specimen is a cylindrical rod 3.6 mm in diameter and 23 cm long with an electric heater at one end and a temperature controlled sink at the other. The specimen is surrounded by glass fiber and a temperature controlled shield. Eight thermocouples are mounted at equally spaced points along the length of the specimen to determine temperature gradients in the range 4 to 300 K.

The experimental data are represented by arbitrary functions over the entire range and smooth tables are generated from these functions. The number of terms used to represent each of the data sets is optimized, through the use of orthonormal functions, so that none of the precision of the data is lost by "underfitting" nor are any necessary oscillations introduced by "overfitting." A detailed description of this apparatus and the methods of data analysis is given by Hust, et al.^[1] Further details are given in the Appendix of this report.

3. Specimen Characterization

An Armco iron rod (2.54 cm diameter and 35.6 cm long) was obtained from Battelle Memorial Institute. Typical composition of Armco iron in weight percent is: 0.015 C, 0.028 Mn, 0.005 P, 0.025 S, 0.003 Si, 0.04 Cu, and 99.9 Fe. This rod was annealed by the supplier as follows: $\frac{1}{2}$ hour at 870°C in a gas-heated air muffle, and then in a quartz capsule at 1×10^{-6} torr for $1\frac{1}{2}$ hours at 875°C, furnace cooled to 150°C, held at 150°C for 24 hours, and furnace cooled to room temperature. We cut the rod into quarters along its axis and cut a 5 cm long piece from each end of each quadrant. These eight pieces were used for electrical residual resistivity ratio, hardness, and grain size measurements. Two of the center 25 cm sections were measured in the thermal conductivity apparatus. The division of the rod and the labeling of specimens is shown in figure 1.

The hardness of these specimens, after machining, was B-40.0. The specimens were subsequently reannealed using the same procedure indicated by the supplier. The hardness after anneal was B-37.1. The grain size approximated from ASTM Chart E112, plate 1 was 0.053 mm and 0.064 mm after machining and after reannealing respectively.

The electrical residual resistivity ratios, RRR, of the eight specimens (1A.... 4A, 1B.... 4B) after machining and of two of these specimens after reannealing are recorded in table 1. These ratios obtained from electrical resistance measurements at 273 K and 4 K in a specially fabricated dip probe, are estimated to be accurate to about 0.2%. Table 1 also contains the resistivity ratios of specimens 2C and 4C. The data marked with asterisks were obtained from the thermal conductivity apparatus.

C. F. Lucks of Battelle Memorial Institute performed similar measurements on another bar of Armco iron.^[3] The rms deviation of his results on six specimens is 6.5% of the mean while the rms deviation of our ten specimens is 3.6%. Lucks made his RRR measurements from 4 K to 298 K; in order to compare absolute values, I adjusted his values to $\rho_{273\text{ K}}/\rho_{4\text{ K}}$ by using $d\rho/dT = 0.05\mu\Omega\text{cm/K}$ at the ice point. This value of $d\rho/dT$ comes from my measurements in the thermal conductivity apparatus. The mean value of RRR (13.65) determined from my data is 5.5% below the mean value reported by Lucks. It is noted from table 1 that the RRR values are lower after annealing. This is an unexplained phenomena at this time, but probably is connected with diffusion of impurities from the grain boundaries upon heat treatment.

4. Results

The transport properties of specimens 2C and 4C were measured in the thermal conductivity apparatus. Specimen 2C was subsequently annealed (same annealing procedure as described before) and remeasured. These data are presented in tables 2 through 7. These specimens are referred to as 2 and 4 respectively in these tables. Specimen 2C after annealing is referred to as 2a.

The experimental data were functionally represented with the following equations:

$$\ln \lambda = \sum_{i=1}^n a_i [\ln T]^{i+1} \quad (1)$$

$$\rho = \sum_{i=1}^m b_i [\ln T]^{i+1} \quad (2)$$

$$S = \sum_{i=1}^l c_i [\ln T']^i / T'; T' = \frac{T}{10} + 1 \quad (3)$$

where λ = thermal conductivity, ρ = electrical resistivity, S = thermopower, and T = temperature. Temperatures are based on the IPTS-68 scale above 20 K and the NBS P2-20 (1965) scale below 20 K. The parameters, a_i , b_i , and c_i , determined by least squares, are presented in tables 8, 9, and 10. Further details of this procedure are described by Hust, et al.^[1] The deviations of the experimental data from these equations are given in tables 11 through 19 and in figures 2 through 10. The "observed" thermal conductivities are computed from the mean temperature gradients indicated by adjacent thermocouples. Calculated values of λ , ρ , S , and $L = \rho\lambda/T$ (Lorenz ratio) are presented in tables 20, 21, and 22 and in figures 11, 12, and 13.

A detailed error analysis for these measurements has been presented previously by Hust, et al.^[1] Based on this analysis of systematic and random errors the uncertainty estimates (with 95% confidence) are as follows:

thermal conductivity: 2.5% at 300 K, decreasing as T^4 to 0.70% at 200 K, 0.70% from 200 K to 50 K, increasing inversely with temperature to 1.5% at 4 K.

electrical resistivity: 0.25%

thermopower: 0.5% + 0.2 μ V/K at 4 K, 0.2% + 0.05 μ V/K at 30 K, and 0.1% + 0.03 μ V/K above 76 K.

The thermopower values given here are absolute values although our measurements were carried out with respect to normal silver wire. The absolute thermopowers of normal silver reported by Borelius, et al.^[4] were used to convert the experimental data to the absolute scale.

5. Discussion

The thermal conductivities of these specimens differ by as much as 10% at low temperatures; the differences observed in electrical resistivity are similar. The thermal conductivity deviations of the three sets of values are shown in figure 14. These data would suggest that Armco iron is a poor thermal conductivity standard at low temperatures. However, upon further examination it is found that this conclusion is not valid. The Lorenz ratio for these measurements is much less variable at low temperatures than either ρ or λ . Figure 15 illustrates the deviations of the Lorenz ratios for each specimen from the mean value.

Since these deviations are not appreciably larger than the uncertainty in the measured Lorenz ratio, the Lorenz ratio is assumed to be invariant from specimen to specimen. Thus one can obtain the electrical resistivity of a particular specimen of Armco iron and compute the thermal conductivity using the Lorenz ratio reported here.

In order for the above procedure to be practical one needs a relatively quick method of generating a ρ vs T curve for a particular specimen from relatively few measurements. Matthiessen's rule indicates that $\rho = \rho_0 + \rho_i$, where ρ_0 is the residual resistivity of the specimen and ρ_i is the intrinsic resistivity of the material. It is known that this rule is not satisfied exactly and that a correction term $\Delta(\rho_0, \rho_i)$ exists. However, if this correction term is sufficiently small one can reconstruct a sufficiently accurate ρ vs T curve for a given specimen from knowledge of ρ_i and measurement of ρ_0 (only one measurement). To investigate this possibility, ρ_i was computed for each specimen using Matthiessen's rule. The relative deviations of the computed values of ρ_i from the mean of three sets is shown in figure 16. This plot shows that ρ_i values for specimens 2, 2a, and 4, as computed from Matthiessen's rule, differ from the mean by less than 0.3% of the resistivity. This deviation is only slightly larger than the estimated uncertainty of the measurements. It is not unreasonable to assume that this result can be extended to other specimens of Armco iron having similar values of ρ_0 and thus, Armco iron can be a useful low temperature standard reference material. This is especially significant, since Armco iron is already in extensive use as a high temperature standard reference material.^[2] The thermal conductivity, λ , of standard reference specimen of Armco iron can be computed from

$$\lambda = \frac{LT}{\rho} = \frac{LT}{\rho_i + \rho_o} \quad (4)$$

where L and ρ_i are given in table 23 and ρ_o is determined by a relatively simple measurement.

The absolute thermopowers of these three specimens are compared in figure 17. The deviations between specimens are only slightly larger than the uncertainty in the tabulated values; thus no significant difference between specimens can be detected from this property.

6. Acknowledgments

I wish to thank C. F. Lucks of Battelle Memorial Institute for supplying the Armco iron rod and information regarding annealing. R. P. Reed and R. L. Durcholz of this laboratory did the hardness and grain size testing. This measurement program has been carried out under the helpful guidance of R. L. Powell.

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2. R. W. Powell, "Armco Iron as a Thermal Conductivity Standard, Review of Published Data", Progress in International Research on Thermodynamics and Transport Properties (eds. J. F. Masi and D. H. Tsai, Academic Press, New York, 1962), pp. 454-465.
3. C. F. Lucks, Private communication.
4. G. Borelius, W. H. Keesom, C. H. Johansson, and J. O. Linde, "Establishment of an Absolute Scale for the Thermoelectric Force", Proc. Kon. Akad. Amsterdam 35, 10 (1932).

Table 1

Residual resistivity ratio (ρ_{273K}/ρ_{4K}) of Armco iron

| Specimen | After machining | After annealing |
|----------|------------------|-----------------|
| 1A | 14.12 | |
| 2A | 13.81 | |
| 3A | 14.13 | |
| 4A | 12.99 | |
| 1B | 13.81 | |
| 2B | 14.51 | 12.88 |
| 3B | 14.09 | |
| 4B | 12.77 | 11.52 |
| 2C | 13.86, 13.83* | 12.58* |
| 4C | 12.44, 13.31* | |

* These values were determined from measurements using the thermal conductivity apparatus.

The data listed in tables 2 thru 7 are, in part, card images of experimental data as read into the computer for data processing. These data are not clearly labelled. The following is a line by line explanation of tables 2, 4, and 6.

- 1st line - Data identification.
- 2nd line - Sample heater voltage (μV), current (mA), platinum resistance thermometer voltage (μV), cryogenic bath pressure (mm of Hg), room temperature ($^{\circ}\text{C}$), platinum resistance thermometer current (mA), code indicating type of cryogenic bath (1 = liquid helium, 2 = liquid hydrogen, 3 = liquid nitrogen, 4 = dry ice-alcohol, 5 = ice-water).
- 3rd line - Thermocouple emfs (μV).
- 4th line - Seebeck emf (μV), specimen current (mA), specimen voltage drop (μV).
- 5th line - Thermocouple temperatures (K).
- 6th line - Heater power (W), reference temperature (K), specimen resistance (Ω).

Table 2. Basic semi-processed temperature gradient data
for Armco iron, specimen 2.

| | | | | | | | |
|--|---------|-----------------------|---------|---------------------|---------|---------|---------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 27AUG68 135PM | | | | | | | |
| 2901060 | 30.1000 | 3841.95 | 92.8 | 21.0 | 1.0 | 3.0 | |
| 155.85 | 192.39 | 229.93 | 267.77 | 305.95 | 344.43 | 383.00 | 422.30 |
| 129.98 | 200.00 | 52.46 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 77.251 | 79.254 | 81.302 | 83.354 | 85.418 | 87.487 | 89.555 | 91.649 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 8.7322-002 | | 68.606 | | 2.6227-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 28AUG68 625 PM | | | | | | | |
| 3856750 | 40.0000 | 4687.70 | 650.0 | 21.0 | 1.0 | 3.0 | |
| 292.10 | 363.46 | 437.18 | 511.91 | 587.84 | 664.82 | 742.62 | 822.12 |
| 318.51 | 200.00 | 75.26 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 92.137 | 95.916 | 99.790 | 103.686 | 107.619 | 111.577 | 115.555 | 119.591 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.5427-001 | | 76.349 | | 3.7630-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 29AUG68 1145AM | | | | | | | |
| 6754900 | 70.0000 | 4738.42 | 653.0 | 21.0 | 1.0 | 3.0 | |
| 743.45 | 992.50 | 1254.80 | 1525.50 | 1804.70 | 2091.04 | 2384.58 | 2686.87 |
| 1343.50 | 200.00 | 150.26 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 116.024 | 128.583 | 141.579 | 154.774 | 168.184 | 181.757 | 195.516 | 209.535 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 4.7284-001 | | 76.811 | | 7.5130-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 100AM | | | | | | | |
| 9614249 | 99.5800 | 4780.40 | 653.0 | 21.0 | 1.0 | 3.0 | |
| 1661.95 | 2251.69 | 2878.90 | 3531.45 | 4208.12 | 4903.67 | 5616.50 | 6353.80 |
| 2724.50 | 200.00 | 315.78 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 161.685 | 189.631 | 218.693 | 248.394 | 278.803 | 309.855 | 341.683 | 374.600 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 9.5739-001 | | 77.192 | | 1.5789-003 | | | |

Table 2 (Cont.)

| | | | | | | | |
|---|---------|-----------------------|--------|---------------------|--------|--------|--------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 220PM | | | | | | | |
| 399637 | 4.1500 | -0.00 | 666.0 | 21.0 | 1.0 | 1.0 | |
| 13.25 | 15.97 | 18.95 | 21.87 | 24.36 | 27.04 | 29.63 | 31.85 |
| -0.03 | 100.00 | 11.66 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 5.010 | 5.229 | 5.446 | 5.650 | 5.846 | 6.032 | 6.206 | 6.378 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.6585-003 | | 4.073 | | 1.1660-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 330PM | | | | | | | |
| 827760 | 8.6000 | -0.00 | 666.0 | 21.0 | 1.0 | 1.0 | |
| 41.08 | 50.58 | 59.93 | 68.88 | 76.99 | 84.86 | 92.26 | 99.07 |
| 0.13 | 200.00 | 23.36 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 6.992 | 7.643 | 8.252 | 8.820 | 9.348 | 9.836 | 10.286 | 10.719 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 7.1187-003 | | 4.073 | | 1.1680-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 630PM | | | | | | | |
| 1265000 | 13.1350 | -0.00 | 653.4 | 21.0 | 1.0 | 1.0 | |
| 109.77 | 125.17 | 140.09 | 154.29 | 167.46 | 179.87 | 191.55 | 202.52 |
| 0.51 | 200.00 | 23.43 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 11.336 | 12.274 | 13.159 | 13.990 | 14.776 | 15.497 | 16.169 | 16.821 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.6616-002 | | 4.054 | | 1.1715-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 710PM | | | | | | | |
| 2182120 | 22.6700 | -0.00 | 654.0 | 21.0 | 1.0 | 1.0 | |
| 216.53 | 247.33 | 276.33 | 303.43 | 328.52 | 351.88 | 373.74 | 394.64 |
| 3.60 | 200.00 | 23.77 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 17.616 | 19.415 | 21.096 | 22.666 | 24.144 | 25.509 | 26.786 | 28.033 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 4.9469-002 | | 4.055 | | 1.1885-004 | | | |

Table 2 (Cont.)

| | | | | | | | |
|---|---------|-----------------------|--------|---------------------|--------|---------|---------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 347PM | | | | | | | |
| 1155030 | 12.0000 | 110.75 | 652.7 | 21.0 | 1.0 | 2.0 | |
| 56.30 | 63.18 | 70.20 | 77.29 | 83.88 | 90.48 | 96.96 | 102.94 |
| 1.04 | 200.00 | 23.82 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 23.127 | 23.540 | 23.947 | 24.356 | 24.753 | 25.137 | 25.509 | 25.873 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.3860-002 | | 19.875 | | 1.1910-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 505PM | | | | | | | |
| 3480880 | 36.1300 | 111.85 | 652.7 | 21.0 | 1.0 | 2.0 | |
| 263.95 | 310.00 | 356.00 | 401.20 | 445.40 | 489.10 | 532.40 | 576.00 |
| 47.20 | 200.00 | 27.43 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 35.483 | 38.257 | 41.016 | 43.716 | 46.360 | 48.946 | 51.488 | 54.051 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.2576-001 | | 19.935 | | 1.3715-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 120PM | | | | | | | |
| 4860190 | 50.4200 | 113.10 | 653.0 | 20.0 | 1.0 | 2.0 | |
| 496.40 | 583.20 | 673.60 | 766.45 | 861.80 | 960.30 | 1061.60 | 1167.10 |
| 241.42 | 200.00 | 39.59 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 49.435 | 54.534 | 59.758 | 65.046 | 70.418 | 75.879 | 81.419 | 87.134 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 2.4505-001 | | 20.003 | | 1.9795-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 430PM | | | | | | | |
| 2335100 | 24.2510 | 111.21 | 654.0 | 21.0 | 1.0 | 2.0 | |
| 106.20 | 131.40 | 156.33 | 180.38 | 203.26 | 225.37 | 246.36 | 266.92 |
| 8.19 | 200.00 | 24.42 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 26.074 | 27.570 | 29.041 | 30.461 | 31.834 | 33.150 | 34.397 | 35.641 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 5.6629-002 | | 19.900 | | 1.2210-004 | | | |

Table 2 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 6SEPT68 1130AM

| | | | | | | |
|---------|---------|----------|--------|--------|--------|----------------|
| 4149800 | 42.9900 | 17240.50 | 631.0 | 21.0 | 1.0 | 4.0 |
| 239.86 | 352.79 | 468.08 | 583.74 | 700.83 | 818.62 | 937.37 1057.68 |
| 544.20 | 200.00 | 240.24 | | | | |

THERMOCOUPLE TEMPERATURES

| | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 204.212 | 209.434 | 214.746 | 220.057 | 225.417 | 230.792 | 236.196 | 241.657 |
|---------|---------|---------|---------|---------|---------|---------|---------|

| | | |
|--------------|-----------------------|---------------------|
| HEATER POWER | REFERENCE TEMPERATURE | SPECIMEN RESISTANCE |
|--------------|-----------------------|---------------------|

| | | |
|------------|---------|------------|
| 1.7840-001 | 193.055 | 1.2012-003 |
|------------|---------|------------|

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 7SEPT68 430 PM

| | | | | | | |
|---------|---------|----------|---------|---------|---------|-----------------|
| 6270555 | 64.9600 | 17299.40 | 627.4 | 22.0 | 1.0 | 4.0 |
| 733.74 | 1001.22 | 1277.22 | 1556.20 | 1841.25 | 2129.90 | 2422.95 2722.05 |
| 1174.06 | 100.00 | 160.62 | | | | |

THERMOCOUPLE TEMPERATURES

| | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 227.472 | 239.645 | 252.132 | 264.687 | 277.470 | 290.357 | 303.441 | 316.795 |
|---------|---------|---------|---------|---------|---------|---------|---------|

| | | |
|--------------|-----------------------|---------------------|
| HEATER POWER | REFERENCE TEMPERATURE | SPECIMEN RESISTANCE |
|--------------|-----------------------|---------------------|

| | | |
|------------|---------|------------|
| 4.0734-001 | 193.620 | 1.6062-003 |
|------------|---------|------------|

The data listed in tables 2 thru 7 are, in part, card images of experimental data as read into the computer for data processing. These data are not labelled clearly. The following is a line by line explanation of tables 3, 5, and 7.

1st line - Data identification.

2nd line - Platinum resistance thermometer voltage (μV), cryogenic bath pressure (mm of Hg), room temperature ($^{\circ}C$), platinum resistance thermometer current (mA), code indicating type of cryogenic bath (1 = liquid helium, 2 = liquid hydrogen, 3 = liquid nitrogen, 4 = dry ice-alcohol, 5 = ice-water), specimen current (mA), specimen voltage (μV), mean emf of eight thermocouples (μV).

3rd line - Reference temperature (K), specimen resistance (Ω), specimen temperature (K).

Table 3. Basic semi-processed isothermal electrical resistivity data for Armco iron, specimen 2.

| | | | | | | | | |
|--|--------|-------|---------------------|------|----------------------|--------|---------|--|
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 26AUG68 840AM | | | | | | | | |
| 3242.83 | 93.20 | 21.00 | 1.00 | 3.00 | 200.00 | 35.64 | 4.77 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 63.027 | | | 1.7820-004 | | 63.298 | | | |
| ----- | | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 26AUG68 930AM | | | | | | | | |
| 3243.31 | 93.20 | 21.00 | 1.00 | 3.00 | 200.00 | 35.54 | 0.79 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 63.031 | | | 1.7770-004 | | 63.076 | | | |
| ----- | | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 26AUG68 950AM | | | | | | | | |
| 3773.15 | 92.80 | 21.00 | 1.00 | 3.00 | 200.00 | 44.90 | 144.01 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 67.971 | | | 2.2450-004 | | 75.983 | | | |
| ----- | | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 28AUG68 930AM | | | | | | | | |
| 4689.61 | 651.60 | 21.00 | 1.00 | 3.00 | 200.00 | 57.58 | 247.16 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 76.367 | | | 2.8787-004 | | 89.764 | | | |
| ----- | | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 29AUG68 110PM | | | | | | | | |
| 4737.00 | 653.00 | 20.00 | 1.00 | 3.00 | 200.00 | 77.94 | 590.44 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 76.798 | | | 3.8970-004 | | 108.179 | | | |
| ----- | | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 29AUG68 600PM | | | | | | | | |
| 4813.05 | 652.50 | 21.00 | 1.00 | 3.00 | 200.00 | 124.82 | 1298.03 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 77.489 | | | 6.2410-004 | | 144.310 | | | |
| ----- | | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 5SEP768 845PM | | | | | | | | |
| 17246.80 | 631.50 | 20.00 | 1.00 | 4.00 | 200.00 | 206.33 | 167.69 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 193.115 | | | 1.0316-003 | | 200.924 | | | |
| ----- | | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 6SEP768 1125PM | | | | | | | | |
| 17316.30 | 628.60 | 21.00 | 1.00 | 4.00 | 100.00 | 118.02 | 569.56 | |
| REFERENCE TEMPERATURE | | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 193.782 | | | 1.1802-003 | | 220.121 | | | |

Table 3 (Cont.)

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 150PM
 -0.00 666.00 21.00 -0.00 1.00 100.00 11.66 11.12
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 4.073 1.1660-004 4.941

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 420PM
 -0.00 654.50 21.00 -0.00 1.00 200.00 23.34 46.74
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 4.055 1.1670-004 7.440

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 520PM
 -0.00 654.00 21.00 -0.00 1.00 200.00 23.37 99.10
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 4.055 1.1685-004 10.762

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 650PM
 -0.00 654.00 21.00 -0.00 1.00 200.00 23.48 195.44
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 4.055 1.1740-004 16.463

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 205PM
 110.30 653.00 21.00 1.00 2.00 200.00 23.59 0.27
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 19.851 1.1795-004 19.866

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 255PM
 110.70 653.00 21.00 1.00 2.00 200.00 23.72 51.78
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 19.873 1.1860-004 22.883

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 1115AM
 112.74 652.00 20.00 1.00 2.00 200.00 27.63 442.23
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 19.983 1.3815-004 46.231

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 255PM
 110.86 654.00 20.00 1.00 2.00 200.00 23.78 69.66
 REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE
 19.881 1.1890-004 23.936

Table 4. Basic semi-processed temperature gradient data
for Armco iron, specimen 2a.

| | | | | | | | |
|--|---------|-----------------------|---------|---------------------|---------|---------|---------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 9 MAR 69 900 AM | | | | | | | |
| 3857600 | 40.0000 | 4707.44 | 647.0 | 24.0 | 1.0 | 3.0 | |
| 176.41 | 246.46 | 318.77 | 392.53 | 467.41 | 543.60 | 620.64 | 699.16 |
| 300.24 | 200.00 | 70.64 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 86.123 | 89.880 | 93.726 | 97.617 | 101.539 | 105.499 | 109.478 | 113.503 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.5430-001 | | 76.529 | | 3.5320-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 1020 AM | | | | | | | |
| 5788935 | 60.0000 | 4703.45 | 648.0 | 23.0 | 1.0 | 3.0 | |
| 222.71 | 384.56 | 555.17 | 732.56 | 915.93 | 1104.85 | 1298.58 | 1497.87 |
| 815.92 | 200.00 | 95.86 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 88.574 | 97.165 | 106.066 | 115.174 | 124.455 | 133.888 | 143.444 | 153.156 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 3.4734-001 | | 76.493 | | 4.7930-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 500 PM | | | | | | | |
| 8067000 | 83.5700 | 4767.78 | 648.0 | 23.0 | 1.0 | 3.0 | |
| 560.81 | 909.22 | 1282.68 | 1675.24 | 2083.94 | 2507.94 | 2946.02 | 3399.18 |
| 1922.36 | 200.00 | 169.05 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 106.908 | 124.653 | 143.186 | 162.222 | 181.652 | 201.478 | 221.674 | 242.313 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 6.7416-001 | | 77.078 | | 8.4525-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 11 MAR 69 440 PM | | | | | | | |
| 3860100 | 40.0000 | 4859.08 | 667.0 | 24.0 | 1.0 | 3.0 | |
| 1077.97 | 1163.31 | 1251.43 | 1340.03 | 1428.79 | 1518.60 | 1608.94 | 1700.87 |
| 432.88 | 200.00 | 133.38 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 133.833 | 138.057 | 142.394 | 146.730 | 151.054 | 155.405 | 159.763 | 164.175 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.5440-001 | | 77.907 | | 6.6690-004 | | | |
| ----- | | | | | | | |

Table 4 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 12 MAR 69 1007 AM

| | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|
| 5792200 | 60.0000 | 4857.50 | 667.0 | 23.0 | 1.0 | 3.0 |
| 1134.58 | 1329.67 | 1532.21 | 1738.83 | 1949.00 | 2163.80 | 2382.15 |
| 1023.47 | 200.00 | 165.30 | | | | |

THERMOCOUPLE TEMPERATURES

| | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 136.624 | 146.213 | 156.052 | 165.979 | 175.979 | 186.106 | 196.320 | 206.680 |
|---------|---------|---------|---------|---------|---------|---------|---------|

HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

| | | |
|------------|--------|------------|
| 3.4753-001 | 77.893 | 8.2650-004 |
|------------|--------|------------|

THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 25 MAR 69 345 PM

| | | | | | | |
|---------|---------|----------|--------|--------|--------|--------|
| 3378470 | 35.0000 | 17217.60 | 630.0 | 24.0 | 1.0 | 4.0 |
| 84.92 | 160.20 | 236.41 | 312.91 | 389.76 | 466.91 | 544.41 |
| 364.64 | 100.00 | 110.50 | | | | |

THERMOCOUPLE TEMPERATURES

| | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 196.796 | 200.298 | 203.834 | 207.374 | 210.922 | 214.476 | 218.037 | 221.625 |
|---------|---------|---------|---------|---------|---------|---------|---------|

HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

| | | |
|------------|---------|------------|
| 1.1825-001 | 192.835 | 1.1050-003 |
|------------|---------|------------|

THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 26 MAR 69 1200 NOON

| | | | | | | |
|---------|---------|----------|--------|--------|---------|---------|
| 4730400 | 49.0000 | 17334.50 | 628.0 | 24.0 | 1.0 | 4.0 |
| 325.98 | 476.80 | 630.52 | 785.49 | 941.76 | 1099.34 | 1258.45 |
| 708.45 | 100.00 | 129.94 | | | | |

THERMOCOUPLE TEMPERATURES

| | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 209.087 | 216.035 | 223.084 | 230.162 | 237.273 | 244.419 | 251.611 | 258.878 |
|---------|---------|---------|---------|---------|---------|---------|---------|

HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

| | | |
|------------|---------|------------|
| 2.3179-001 | 193.957 | 1.2994-003 |
|------------|---------|------------|

THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 26 MAR 69 715 PM

| | | | | | | |
|---------|---------|----------|---------|---------|---------|---------|
| 6446500 | 66.7800 | 17323.50 | 628.0 | 24.0 | 1.0 | 4.0 |
| 393.58 | 676.56 | 967.21 | 1262.70 | 1562.96 | 1867.55 | 2177.29 |
| 1276.16 | 100.00 | 150.84 | | | | |

THERMOCOUPLE TEMPERATURES

| | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|
| 212.101 | 225.086 | 238.326 | 251.701 | 265.212 | 278.865 | 292.694 | 306.779 |
|---------|---------|---------|---------|---------|---------|---------|---------|

HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

| | | |
|------------|---------|------------|
| 4.3050-001 | 193.851 | 1.5084-003 |
|------------|---------|------------|

Table 4 (Cont.)

| | | | | | | | |
|--|---------|-----------------------|--------|---------------------|---------|---------|---------|
| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 13 MAR 69 1215 PM | | | | | | | |
| 3485400 | 36.1700 | 113.35 | 649.0 | 23.0 | 1.0 | 2.0 | |
| 121.93 | 179.47 | 233.65 | 285.60 | 334.52 | 382.52 | 429.04 | 474.74 |
| 35.68 | 200.00 | 28.20 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 27.118 | 30.535 | 33.761 | 36.867 | 39.815 | 42.691 | 45.459 | 48.185 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.2607-001 | | 20.016 | | 1.4100-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 13 MAR 69 300 PM | | | | | | | |
| 5068460 | 52.5700 | 115.82 | 649.0 | 23.0 | 1.0 | 2.0 | |
| 219.36 | 324.83 | 426.15 | 526.76 | 627.07 | 729.72 | 834.48 | 943.00 |
| 175.46 | 200.00 | 34.37 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 33.034 | 39.367 | 45.427 | 51.371 | 57.226 | 63.110 | 69.019 | 75.068 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 2.6645-001 | | 20.147 | | 1.7185-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 13 MAR 69 520 PM | | | | | | | |
| 5634400 | 58.4200 | 120.00 | 649.0 | 23.0 | 1.0 | 2.0 | |
| 413.50 | 534.83 | 660.15 | 790.32 | 925.50 | 1066.90 | 1213.85 | 1367.52 |
| 368.80 | 200.00 | 44.98 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 44.888 | 52.073 | 59.343 | 66.746 | 74.305 | 82.053 | 89.959 | 98.108 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 3.2916-001 | | 20.364 | | 2.2490-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 7 MAR 69 500 PM | | | | | | | |
| 2404575 | 24.9400 | 4655.48 | 643.0 | 24.0 | 1.0 | 3.0 | |
| 39.78 | 65.57 | 91.85 | 118.38 | 145.02 | 171.87 | 198.65 | 225.74 |
| 89.71 | 200.00 | 53.60 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 78.236 | 79.648 | 81.081 | 82.521 | 83.965 | 85.414 | 86.858 | 88.310 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 5.9970-002 | | 76.056 | | 2.6800-004 | | | |
| ----- | | | | | | | |

Table 4 (Cont.)

| | | | | | | | |
|---|---------|-----------------------|--------|---------------------|--------|--------|--------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 433PM | | | | | | | |
| 456730 | 4.7420 | -0.00 | 672.0 | 24.0 | 1.0 | 1.0 | |
| 11.55 | 15.56 | 19.62 | 23.72 | 27.26 | 31.03 | 34.60 | 37.75 |
| 0.01 | 200.00 | 25.84 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 4.889 | 5.207 | 5.503 | 5.792 | 6.061 | 6.321 | 6.560 | 6.793 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 2.1658-003 | | 4.082 | | 1.2920-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 545 PM | | | | | | | |
| 696128 | 7.2300 | -0.00 | 672.0 | 24.0 | -0.0 | 1.0 | |
| 27.32 | 35.46 | 43.27 | 51.01 | 57.87 | 64.80 | 71.31 | 77.23 |
| 0.10 | 200.00 | 25.86 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 6.045 | 6.629 | 7.159 | 7.668 | 8.133 | 8.576 | 8.983 | 9.372 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 5.0330-003 | | 4.082 | | 1.2930-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 715 PM | | | | | | | |
| 1151310 | 11.9600 | -0.00 | 672.0 | 24.0 | -0.0 | 1.0 | |
| 49.97 | 68.54 | 85.71 | 101.86 | 116.22 | 130.11 | 142.94 | 154.76 |
| 0.43 | 200.00 | 25.90 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 7.595 | 8.816 | 9.893 | 10.880 | 11.763 | 12.590 | 13.342 | 14.053 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.3770-002 | | 4.082 | | 1.2950-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 810 PM | | | | | | | |
| 1908125 | 19.8200 | -0.00 | 672.0 | 23.0 | -0.0 | 1.0 | |
| 100.81 | 138.67 | 172.10 | 202.63 | 229.38 | 254.61 | 277.63 | 298.90 |
| 1.99 | 200.00 | 26.03 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 10.813 | 13.098 | 15.061 | 16.832 | 18.398 | 19.857 | 21.185 | 22.437 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 3.7819-002 | | 4.082 | | 1.3015-004 | | | |

Table 4 (Cont.)

| | | | | | | | |
|--|---------|-----------------------|--------|---------------------|--------|--------|--------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1045 AM | | | | | | | |
| 2325375 | 24.1500 | -0.00 | 673.0 | 24.0 | -0.0 | 1.0 | |
| 139.30 | 186.94 | 228.56 | 266.27 | 299.35 | 330.40 | 358.83 | 385.28 |
| 4.21 | 200.00 | 26.18 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 13.124 | 15.930 | 18.345 | 20.525 | 22.462 | 24.271 | 25.929 | 27.501 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 5.6158-002 | | 4.083 | | 1.3090-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1200 NOON | | | | | | | |
| 1263105 | 13.1210 | -0.00 | 673.0 | 24.0 | -0.0 | 1.0 | |
| 188.06 | 200.57 | 212.93 | 225.14 | 236.24 | 247.37 | 257.94 | 267.77 |
| 0.84 | 200.00 | 26.05 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 15.983 | 16.723 | 17.438 | 18.139 | 18.796 | 19.438 | 20.043 | 20.627 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.6573-002 | | 4.083 | | 1.3025-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 12 MAR 69 540 PM | | | | | | | |
| 1433200 | 14.8850 | 110.03 | 649.0 | 23.0 | 1.0 | 2.0 | |
| 23.33 | 35.79 | 48.24 | 60.57 | 72.00 | 83.41 | 94.39 | 104.71 |
| 1.82 | 200.00 | 26.28 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 21.168 | 21.904 | 22.625 | 23.339 | 24.018 | 24.682 | 25.318 | 25.937 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 2.1333-002 | | 19.836 | | 1.3140-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 1015 AM | | | | | | | |
| 2022330 | 21.0000 | 111.79 | 649.0 | 23.0 | 1.0 | 2.0 | |
| 58.57 | 81.15 | 103.20 | 124.72 | 144.72 | 164.32 | 182.98 | 200.74 |
| 5.37 | 200.00 | 26.58 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 23.316 | 24.648 | 25.938 | 27.199 | 28.391 | 29.549 | 30.649 | 31.719 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 4.2469-002 | | 19.932 | | 1.3290-004 | | | |
| ----- | | | | | | | |

Table 4 (Cont.)

| | | | | | | | |
|--|---------|-----------------------|---------|---------------------|---------|---------|---------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 27 MAR 69 445 PM | | | | | | | |
| 2896500 | 30.0000 | 17492.50 | 624.0 | 24.0 | 1.0 | 4.0 | |
| 836.10 | 894.12 | 953.57 | 1012.84 | 1071.74 | 1130.78 | 1190.16 | 1250.63 |
| 263.21 | 100.00 | 137.56 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 233.947 | 236.585 | 239.285 | 241.973 | 244.641 | 247.312 | 249.995 | 252.724 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 8.6895-002 | | 195.473 | | 1.3756-003 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 3 APRIL 69 430 PM | | | | | | | |
| 2878800 | 29.8200 | 25486.20 | 620.0 | 23.0 | 1.0 | 5.0 | |
| 60.32 | 121.19 | 182.76 | 244.43 | 306.20 | 368.06 | 430.24 | 492.86 |
| 245.31 | 100.00 | 173.34 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 275.998 | 278.715 | 281.464 | 284.218 | 286.975 | 289.737 | 292.513 | 295.309 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 8.5846-002 | | 273.288 | | 1.7334-003 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 4 APRIL 69 920 AM | | | | | | | |
| 2896200 | 30.0000 | 25510.00 | 628.0 | 23.0 | 1.0 | 5.0 | |
| 60.90 | 122.44 | 184.73 | 247.11 | 309.60 | 372.20 | 435.15 | 498.55 |
| 247.90 | 100.00 | 173.69 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 276.257 | 279.005 | 281.786 | 284.571 | 287.361 | 290.156 | 292.966 | 295.797 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 8.6886-002 | | 273.523 | | 1.7369-003 | | | |
| ----- | | | | | | | |

Table 5. Basic semi-processed isothermal electrical resistivity data for Armco iron, specimen 2a.

| | | | | | | | |
|---|--------|---------------------|-------|----------------------|--------|--------|---------|
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 19 MAR 69 230 PM | | | | | | | |
| -0.00 | 665.00 | 24.00 | -0.00 | 1.00 | 200.00 | 25.83 | 0.75 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 4.071 | | 1.2915-004 | | 4.132 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 12 MAR 69 445 PM | | | | | | | |
| 109.62 | 649.00 | 23.00 | 1.00 | 2.00 | 200.00 | 26.10 | 0.09 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 19.813 | | 1.3050-004 | | 19.818 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 7 MAR 69 125 PM | | | | | | | |
| 4641.75 | 643.00 | 23.00 | 1.00 | 3.00 | 100.00 | 23.58 | 0.05 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 75.931 | | 2.3580-004 | | 75.934 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 8 MAR 69 1020 AM | | | | | | | |
| 4702.60 | 643.00 | 23.00 | 1.00 | 3.00 | 200.00 | 54.44 | 141.37 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 76.485 | | 2.7220-004 | | 84.195 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 11 MAR 69 1055 AM | | | | | | | |
| 4859.10 | 665.00 | 24.00 | 1.00 | 3.00 | 200.00 | 109.88 | 1034.62 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 77.907 | | 5.4940-004 | | 131.684 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 23 MAR 69 730 PM | | | | | | | |
| 17207.00 | 632.00 | 25.00 | 1.00 | 4.00 | 200.00 | 196.01 | 0.57 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 192.734 | | 9.8005-004 | | 192.760 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 2 APRIL 69 415 PM | | | | | | | |
| 25477.80 | 624.00 | 26.00 | 1.00 | 5.00 | 100.00 | 162.50 | 0.22 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 273.206 | | 1.6250-003 | | 273.215 | | | |
| ----- | | | | | | | |

Table 6. Basic semi-processed temperature gradient data
for Armco iron, specimen 4.

| | | | | | | | |
|---|---------|---------|-----------------------|---------------------|---------|---------|--------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68 | | | | | | | 1140AM |
| 1922030 | 19.9400 | 4653.41 | 644.0 | 22.0 | 1.0 | 3.0 | |
| 45.40 | 62.00 | 78.90 | 95.80 | 112.82 | 129.86 | 146.96 | |
| 55.32 | 200.00 | 52.72 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 78.525 | 79.434 | 80.357 | 81.276 | 82.202 | 83.124 | 84.052 | |
| HEATER POWER | | | REFERENCE TEMPERATURE | SPECIMEN RESISTANCE | | | |
| 3.8325-002 | | | 76.037 | 2.6360-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68 | | | | | | | 540PM |
| 3369920 | 34.9500 | 4657.94 | 636.0 | 23.0 | 1.0 | 3.0 | |
| 180.11 | 233.73 | 288.93 | 344.72 | 401.42 | 458.72 | 516.92 | |
| 218.50 | 200.00 | 67.46 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 85.882 | 88.762 | 91.707 | 94.665 | 97.655 | 100.657 | 103.692 | |
| HEATER POWER | | | REFERENCE TEMPERATURE | SPECIMEN RESISTANCE | | | |
| 1.1778-001 | | | 76.078 | 3.3730-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 12 DEC 68 | | | | | | | 1130AM |
| 5301325 | 54.9500 | 4692.75 | 636.0 | 21.0 | 1.0 | 3.0 | |
| 477.40 | 622.71 | 774.73 | 930.44 | 1090.42 | 1253.67 | 1420.97 | |
| 734.22 | 200.00 | 108.19 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 101.934 | 109.460 | 117.232 | 125.095 | 133.085 | 141.150 | 149.336 | |
| HEATER POWER | | | REFERENCE TEMPERATURE | SPECIMEN RESISTANCE | | | |
| 2.9131-001 | | | 76.395 | 5.4095-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 13 DEC 68 | | | | | | | 915AM |
| 7239100 | 75.0000 | 4792.45 | 653.0 | 23.0 | 1.0 | 3.0 | |
| 1467.10 | 1786.68 | 2122.80 | 2467.42 | 2821.28 | 3123.34 | 3554.75 | |
| 1636.76 | 200.00 | 223.17 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 152.379 | 167.752 | 183.675 | 199.786 | 216.138 | 232.694 | 249.537 | |
| HEATER POWER | | | REFERENCE TEMPERATURE | SPECIMEN RESISTANCE | | | |
| 5.4293-001 | | | 77.302 | 1.1159-003 | | | |
| ----- | | | | | | | |

Table 6 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 13 DEC 68 835PM
 7249400 75.1000 4807.35 665.0 23.0 1.0 3.0
 2475.63 2824.80 3191.90 3565.48 3947.07 4335.84 4734.08 5140.98
 1597.60 200.00 305.46

THERMOCOUPLE TEMPERATURES

200.283 216.414 233.198 250.132 267.304 284.703 302.485 320.650
 HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE
 5.4443-001 77.437 1.5273-003

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 19DEC 68 500PM
 4114970 42.6300 17179.60 621.0 22.0 1.0 4.0
 227.50 338.91 453.24 568.14 684.31 801.22 919.39 1038.88
 534.88 200.00 241.62

THERMOCOUPLE TEMPERATURES

203.059 208.216 213.488 218.768 224.090 229.429 234.810 240.238
 HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE
 1.7542-001 192.471 1.2081-003

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 20DEC 68 1025AM
 6274450 65.0000 17299.90 621.0 21.0 1.0 4.0
 1005.08 1279.67 1565.42 1854.66 2149.00 2446.90 2750.30 3059.00
 1149.44 200.00 348.82

THERMOCOUPLE TEMPERATURES

239.825 252.247 265.105 278.073 291.214 304.515 318.060 331.843
 HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE
 4.0784-001 193.625 1.7441-003

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 20DEC 68 340PM
 5075600 52.5800 17290.80 620.0 21.0 1.0 4.0
 630.10 804.70 985.10 1166.90 1351.14 1536.93 1725.25 1916.18
 794.32 200.00 290.30

THERMOCOUPLE TEMPERATURES

222.654 230.628 238.833 247.070 255.385 263.742 272.191 280.736
 HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE
 2.6688-001 193.537 1.4515-003

Table 6 (Cont.)

| | | | | | | | |
|---|---------|-----------------------|--------|---------------------|--------|--------|--------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1135 AM | | | | | | | |
| 404476 | 4.2000 | -0.00 | 653.0 | 23.0 | -0.0 | 1.0 | |
| 17.57 | 20.46 | 23.52 | 26.60 | 29.29 | 32.21 | 35.13 | 37.71 |
| -0.03 | 200.00 | 26.06 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 5.313 | 5.541 | 5.760 | 5.972 | 6.179 | 6.379 | 6.572 | 6.766 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.6988-003 | | 4.053 | | 1.3030-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1225PM | | | | | | | |
| 712335 | 7.4000 | -0.00 | 654.0 | 24.0 | -0.0 | 1.0 | |
| 40.55 | 48.39 | 56.02 | 63.42 | 70.15 | 76.91 | 83.48 | 89.53 |
| 0.06 | 200.00 | 26.09 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 6.940 | 7.482 | 7.982 | 8.455 | 8.901 | 9.324 | 9.727 | 10.118 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 5.2713-003 | | 4.054 | | 1.3045-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 130PM | | | | | | | |
| 1102950 | 11.4600 | -0.00 | 653.0 | 24.0 | -0.0 | 1.0 | |
| 90.17 | 104.38 | 117.90 | 130.75 | 142.61 | 154.17 | 165.30 | 175.69 |
| 0.31 | 200.00 | 26.14 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 10.137 | 11.021 | 11.835 | 12.597 | 13.314 | 13.991 | 14.636 | 15.258 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.2640-002 | | 4.053 | | 1.3070-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 505PM | | | | | | | |
| 404467 | 4.2000 | -0.00 | 654.0 | 24.0 | -0.0 | 1.0 | |
| 17.78 | 20.81 | 23.93 | 27.07 | 29.79 | 32.76 | 35.66 | 38.19 |
| -0.02 | 200.00 | 26.06 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 5.330 | 5.568 | 5.791 | 6.007 | 6.215 | 6.418 | 6.609 | 6.800 |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.6988-003 | | 4.054 | | 1.3030-004 | | | |

Table 6 (Cont.)

| | | | | | | | |
|---|---------|--------|--------|---------------------|--------|--------|--------|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 540PM | | | | | | | |
| 1973298 | 20.5000 | -0.00 | 654.0 | 23.0 | -0.0 | 1.0 | |
| 200.92 | 230.19 | 257.34 | 282.63 | 306.01 | 328.25 | 349.51 | 369.68 |
| 2.68 | 200.00 | 26.44 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 16.710 | 18.421 | 19.993 | 21.455 | 22.829 | 24.124 | 25.361 | 26.560 |
| HEATER POWER REFERENCE TEMPERATURE | | | | SPECIMEN RESISTANCE | | | |
| 4.0453-002 | | 4.054 | | 1.3220-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 600PM | | | | | | | |
| 1973298 | 20.5000 | -0.00 | 654.0 | 23.0 | -0.0 | 1.0 | |
| 201.11 | 230.50 | 257.74 | 283.13 | 306.70 | 328.90 | 350.22 | 370.46 |
| 2.72 | 200.00 | 26.44 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 16.721 | 18.439 | 20.016 | 21.484 | 22.870 | 24.162 | 25.403 | 26.606 |
| HEATER POWER REFERENCE TEMPERATURE | | | | SPECIMEN RESISTANCE | | | |
| 4.0453-002 | | 4.054 | | 1.3220-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 635PM | | | | | | | |
| 1386400 | 14.4050 | -0.00 | 654.0 | 23.0 | -0.0 | 1.0 | |
| 146.98 | 164.66 | 181.48 | 197.47 | 212.33 | 226.66 | 240.45 | 253.44 |
| 0.73 | 200.00 | 26.24 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 13.557 | 14.608 | 15.589 | 16.512 | 17.389 | 18.216 | 19.007 | 19.775 |
| HEATER POWER REFERENCE TEMPERATURE | | | | SPECIMEN RESISTANCE | | | |
| 1.9971-002 | | 4.054 | | 1.3120-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 1140AM | | | | | | | |
| 869115 | 9.0300 | 110.56 | 654.0 | 23.0 | 1.0 | 2.0 | |
| 32.21 | 36.70 | 41.39 | 46.06 | 50.39 | 54.87 | 59.34 | 63.47 |
| 0.49 | 200.00 | 26.45 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 21.713 | 21.986 | 22.256 | 22.522 | 22.785 | 23.044 | 23.297 | 23.551 |
| HEATER POWER REFERENCE TEMPERATURE | | | | SPECIMEN RESISTANCE | | | |
| 7.8481-003 | | 19.865 | | 1.3225-004 | | | |

Table 6 (Cont.)

| | | | | | | | |
|--|---------|-----------------------|--------|---------------------|---------|---------|--|
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 115PM | | | | | | | |
| 1250400 | 12.9900 | 110.86 | 653.0 | 23.0 | 1.0 | 2.0 | |
| 62.52 | 71.31 | 80.14 | 88.85 | 97.15 | 105.37 | 113.61 | |
| 1.41 | 200.00 | 26.60 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 23.496 | 24.021 | 24.535 | 25.039 | 25.537 | 26.017 | 26.494 | |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.6243-002 | | 19.881 | | 1.3300-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 230PM | | | | | | | |
| 2211800 | 22.9700 | 111.59 | 653.0 | 23.0 | 1.0 | 2.0 | |
| 129.90 | 153.78 | 177.13 | 199.70 | 221.34 | 242.44 | 263.27 | |
| 8.60 | 200.00 | 27.30 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 27.491 | 28.914 | 30.295 | 31.632 | 32.934 | 34.192 | 35.431 | |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 5.0805-002 | | 19.921 | | 1.3650-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 455PM | | | | | | | |
| 3816900 | 39.6100 | 113.55 | 653.0 | 23.0 | 1.0 | 2.0 | |
| 300.91 | 359.37 | 417.23 | 474.16 | 530.87 | 587.49 | 645.15 | |
| 77.53 | 200.00 | 32.00 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 37.794 | 41.316 | 44.772 | 48.148 | 51.501 | 54.807 | 58.139 | |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 1.5119-001 | | 20.027 | | 1.6000-004 | | | |
| ----- | | | | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 18DEC68 1150AM | | | | | | | |
| 4648820 | 48.2200 | 117.32 | 653.0 | 22.0 | 1.0 | 2.0 | |
| 638.00 | 724.70 | 815.35 | 908.42 | 1004.10 | 1102.30 | 1204.40 | |
| 282.46 | 200.00 | 48.53 | | | | | |
| THERMOCOUPLE TEMPERATURES | | | | | | | |
| 57.922 | 62.903 | 68.026 | 73.216 | 78.500 | 83.843 | 89.327 | |
| HEATER POWER | | REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | | |
| 2.2417-001 | | 20.226 | | 2.4265-004 | | | |

Table 7. Basic semi-processed isothermal electrical resistivity data for Armco iron, specimen 4.

| | | | | | | | |
|---|--------|---------------------|-------|----------------------|---------|--------|--------|
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 16DEC68 | 1050AM | |
| -0.00 | 653.00 | 23.00 | -0.00 | 1.00 | 200.00 | 26.06 | 4.28 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 4.053 | | 1.3030-004 | | 4.394 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 16DEC68 | 100PM | |
| -0.00 | 654.50 | 24.00 | -0.00 | 1.00 | 200.00 | 26.10 | 81.83 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 4.055 | | 1.3050-004 | | 9.696 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 16DEC68 | 155PM | |
| -0.00 | 653.00 | 24.00 | -0.00 | 1.00 | 200.00 | 26.20 | 183.83 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 4.053 | | 1.3100-004 | | 15.786 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 16DEC68 | 700PM | |
| -0.00 | 654.00 | 23.00 | -0.00 | 1.00 | 200.00 | 26.33 | 257.60 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 4.054 | | 1.3165-004 | | 20.069 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 17DEC68 | 1045AM | |
| 110.22 | 653.50 | 23.00 | 1.00 | 2.00 | 200.00 | 26.32 | 0.55 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 19.846 | | 1.3160-004 | | 19.878 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 17DEC68 | 140PM | |
| 111.62 | 653.00 | 23.00 | 1.00 | 2.00 | 200.00 | 26.71 | 116.83 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 19.923 | | 1.3355-004 | | 26.745 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 17DEC68 | 255PM | |
| 113.58 | 653.50 | 23.00 | 1.00 | 2.00 | 200.00 | 27.83 | 269.55 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 20.028 | | 1.3915-004 | | 35.938 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 17DEC68 | 530PM | |
| 117.54 | 653.00 | 23.00 | 1.00 | 2.00 | 200.00 | 34.06 | 593.61 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 20.237 | | 1.7030-004 | | 55.386 | | | |
| ----- | | | | | | | |

Table 7 (Cont.)

| | | | | | | | |
|---|--------|---------------------|------|----------------------|----------------|--------|---------|
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 18DEC68 250PM | | |
| 117.92 | 653.50 | 22.00 | 1.00 | 2.00 | 200.00 | 48.59 | 978.12 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 20.257 | | 2.4295-004 | | 77.113 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 10DEC68 620PM | | |
| 4604.18 | 630.00 | 23.00 | 1.00 | 3.00 | 200.00 | 47.55 | 2.71 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 75.589 | | 2.3775-004 | | 75.738 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 11DEC68 143PM | | |
| 4658.02 | 636.00 | 23.00 | 1.00 | 3.00 | 200.00 | 55.20 | 151.78 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 76.079 | | 2.7600-004 | | 84.360 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 11DEC68 1000PM | | |
| 4689.33 | 636.00 | 22.00 | 1.00 | 3.00 | 200.00 | 69.23 | 402.76 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 76.364 | | 3.4615-004 | | 98.003 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 12DEC68 445PM | | |
| 4766.59 | 636.00 | 24.00 | 1.00 | 3.00 | 200.00 | 127.62 | 1302.61 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 77.067 | | 6.3810-004 | | 144.158 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 13DEC68 510PM | | |
| 4808.22 | 666.00 | 24.00 | 1.00 | 3.00 | 200.00 | 196.50 | 2293.19 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 77.445 | | 9.8250-004 | | 191.793 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 19DEC68 145PM | | |
| 17156.40 | 621.00 | 22.00 | 1.00 | 4.00 | 200.00 | 197.80 | 19.11 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 192.249 | | 9.8900-004 | | 193.141 | | | |
| ----- | | | | | | | |
| ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) | | | | | 19DEC68 620PM | | |
| 17290.00 | 621.00 | 22.00 | 1.00 | 4.00 | 200.00 | 260.64 | 866.01 |
| REFERENCE TEMPERATURE | | SPECIMEN RESISTANCE | | SPECIMEN TEMPERATURE | | | |
| 193.530 | | 1.3032-003 | | 233.413 | | | |

Table 8. Parameters in eqs. 1, 2, and 3 for Armco iron, specimen 2.

| COEFFICIENTS FOR | | |
|-------------------------|---------------------------|-----------------|
| THERMAL CONDUCTIVITY | ELECTRICAL RESISTIVITY | THERMOPOWER |
| 4.51614994+000 | -4.95025810-007 | -3.44881675+002 |
| -4.13926935+000 | 1.65473929-006 | 2.37913833+003 |
| 2.07599685+000 | -2.37099406-006 | -6.68364762+003 |
| -8.61606749-001 | 1.93668635-006 | 9.99411766+003 |
| 3.39315321-001 | -9.93191337-007 | -8.67747098+003 |
| -9.99896812-002 | 3.31399468-007 | 4.46376537+003 |
| 1.79360964-002 | -7.18946332-008 | -1.32173829+003 |
| -1.71155124-003 | 9.77121499-009 | 2.08103179+002 |
| 6.66070951-005 | -7.54546890-010 | -1.35462989+001 |
| | 2.52377946-011 | |

Table 9. Parameters in eqs. 1, 2, and 3 for Armco iron, specimen 2a.

| COEFFICIENTS FOR | | |
|-------------------------|---------------------------|-----------------|
| THERMAL CONDUCTIVITY | ELECTRICAL RESISTIVITY | THERMOPOWER |
| 7.43890940+000 | -4.20510751-007 | -5.10933863+002 |
| -1.14675555+001 | 1.45081937-006 | 3.36812410+003 |
| 9.73124560+000 | -2.12826875-006 | -9.06609424+003 |
| -5.28250471+000 | 1.77366602-006 | 1.30552541+004 |
| 1.89245802+000 | -9.25249389-007 | -1.09917641+004 |
| -4.41102771-001 | 3.13228379-007 | 5.52800895+003 |
| 6.37973455-002 | -6.87884712-008 | -1.61455399+003 |
| -5.17020759-003 | 9.44600166-009 | 2.52389423+002 |
| 1.78835874-004 | -7.35822503-010 | -1.63749922+001 |
| | 2.47951038-011 | |

Table 10. Parameters in eqs. 1, 2, and 3 for Armco iron, specimen 4.

| COEFFICIENTS FOR | | |
|-------------------------|---------------------------|-----------------|
| THERMAL CONDUCTIVITY | ELECTRICAL RESISTIVITY | THERMOPOWER |
| 8.21226100+000 | -5.03088441-007 | -6.42943844+002 |
| -1.32577224+001 | 1.69059561-006 | 4.14540857+003 |
| 1.14738701+001 | -2.42733181-006 | -1.09289158+004 |
| -6.21776147+000 | 1.98402296-006 | 1.54381788+004 |
| 2.19527810+000 | -1.01722378-006 | -1.27838650+004 |
| -5.01619108-001 | 3.39158569-007 | 6.34295244+003 |
| 7.10720281-002 | -7.35034919-008 | -1.83456286+003 |
| -5.64940725-003 | 9.97927431-009 | 2.84809534+002 |
| 1.91995267-004 | -7.69854134-010 | -1.83820643+001 |
| | 2.57278514-011 | |

These parameters are listed in E format. This format is illustrated by the following example: 1.788-004 = 1.788×10^{-4}

Table 11 Thermal conductivity deviations for Armco iron, specimen 2.

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 28AUG68 625 PM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 94.026 | 3.779 | 9.86+001 | 9.88+001 | -0.2 |
| 97.853 | 3.874 | 9.59+001 | 9.73+001 | -1.5 |
| 101.738 | 3.896 | 9.55+001 | 9.60+001 | -0.5 |
| 105.653 | 3.933 | 9.45+001 | 9.47+001 | -0.2 |
| 109.598 | 3.958 | 9.41+001 | 9.35+001 | 0.6 |
| 113.566 | 3.978 | 9.36+001 | 9.24+001 | 1.3 |
| 117.573 | 4.036 | 9.24+001 | 9.14+001 | 1.1 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 29AUG68 1145AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 122.304 | 12.559 | 9.09+001 | 9.03+001 | 0.7 |
| 135.081 | 12.996 | 8.76+001 | 8.79+001 | -0.2 |
| 148.177 | 13.194 | 8.64+001 | 8.60+001 | 0.5 |
| 161.479 | 13.410 | 8.49+001 | 8.46+001 | 0.4 |
| 174.970 | 13.572 | 8.41+001 | 8.35+001 | 0.7 |
| 188.636 | 13.759 | 8.29+001 | 8.25+001 | 0.5 |
| 202.525 | 14.020 | 8.15+001 | 8.16+001 | -0.2 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 100AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 175.658 | 27.946 | 8.27+001 | 8.34+001 | -0.9 |
| 204.162 | 29.062 | 7.94+001 | 8.15+001 | -2.7 |
| 233.544 | 29.701 | 7.77+001 | 7.95+001 | -2.3 |
| 263.598 | 30.409 | 7.58+001 | 7.72+001 | -1.9 |
| 294.329 | 31.053 | 7.44+001 | 7.47+001 | -0.4 |
| 325.769 | 31.827 | 7.26+001 | 7.23+001 | 0.3 |
| 358.141 | 32.917 | 7.03+001 | 7.06+001 | -0.5 |

Table 11 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 220PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 5.119 | 0.219 | 1.83+001 | 1.80+001 | 1.7 |
| 5.338 | 0.217 | 1.84+001 | 1.89+001 | -2.7 |
| 5.548 | 0.204 | 1.96+001 | 1.98+001 | -1.0 |
| 5.748 | 0.196 | 2.04+001 | 2.06+001 | -1.3 |
| 5.939 | 0.186 | 2.15+001 | 2.14+001 | 0.4 |
| 6.119 | 0.173 | 2.31+001 | 2.21+001 | 4.2 |
| 6.292 | 0.172 | 2.32+001 | 2.28+001 | 1.8 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 330PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 7.317 | 0.651 | 2.64+001 | 2.67+001 | -1.2 |
| 7.947 | 0.610 | 2.81+001 | 2.91+001 | -3.3 |
| 8.536 | 0.568 | 3.02+001 | 3.12+001 | -3.1 |
| 9.084 | 0.528 | 3.25+001 | 3.31+001 | -2.1 |
| 9.592 | 0.488 | 3.52+001 | 3.50+001 | 0.8 |
| 10.061 | 0.449 | 3.82+001 | 3.66+001 | 4.2 |
| 10.502 | 0.433 | 3.98+001 | 3.82+001 | 3.9 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 630PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 11.805 | 0.938 | 4.27+001 | 4.28+001 | -0.2 |
| 12.717 | 0.885 | 4.52+001 | 4.61+001 | -1.9 |
| 13.575 | 0.831 | 4.82+001 | 4.92+001 | -2.0 |
| 14.383 | 0.786 | 5.09+001 | 5.21+001 | -2.3 |
| 15.136 | 0.721 | 5.56+001 | 5.48+001 | 1.5 |
| 15.833 | 0.672 | 5.96+001 | 5.73+001 | 3.9 |
| 16.495 | 0.652 | 6.16+001 | 5.97+001 | 3.2 |
| ----- | | | | |

Table 11 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2) 30AUG68 710PM

| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
|---------------------|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| 18.516 | 1.798 | 6.64+001 | 6.67+001 | -0.5 |
| 20.255 | 1.681 | 7.09+001 | 7.26+001 | -2.4 |
| 21.881 | 1.570 | 7.60+001 | 7.78+001 | -2.4 |
| 23.405 | 1.478 | 8.06+001 | 8.24+001 | -2.3 |
| 24.826 | 1.365 | 8.75+001 | 8.65+001 | 1.2 |
| 26.147 | 1.277 | 9.35+001 | 9.00+001 | 3.7 |
| 27.409 | 1.247 | 9.59+001 | 9.32+001 | 2.8 |

THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2) 3SEPT68 347PM

| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
|---------------------|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| 23.334 | 0.413 | 8.10+001 | 8.22+001 | -1.6 |
| 23.744 | 0.407 | 8.21+001 | 8.34+001 | -1.6 |
| 24.151 | 0.409 | 8.18+001 | 8.46+001 | -3.5 |
| 24.554 | 0.397 | 8.41+001 | 8.57+001 | -2.0 |
| 24.945 | 0.384 | 8.72+001 | 8.68+001 | 0.4 |
| 25.323 | 0.373 | 8.98+001 | 8.78+001 | 2.1 |
| 25.691 | 0.364 | 9.20+001 | 8.88+001 | 3.4 |

THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2) 3SEPT68 505PM

| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
|---------------------|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| 36.870 | 2.774 | 1.09+002 | 1.10+002 | -0.1 |
| 39.637 | 2.758 | 1.10+002 | 1.12+002 | -2.2 |
| 42.366 | 2.700 | 1.12+002 | 1.14+002 | -1.6 |
| 45.038 | 2.645 | 1.15+002 | 1.15+002 | -0.6 |
| 47.653 | 2.586 | 1.17+002 | 1.16+002 | 1.3 |
| 50.217 | 2.542 | 1.19+002 | 1.16+002 | 2.8 |
| 52.769 | 2.563 | 1.19+002 | 1.16+002 | 2.3 |

Table 11 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 120PM

| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
|---------------------|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| 51.984 | 5.099 | 1.16+002 | 1.16+002 | 0.1 |
| 57.146 | 5.224 | 1.13+002 | 1.15+002 | -1.7 |
| 62.402 | 5.288 | 1.12+002 | 1.13+002 | -1.2 |
| 67.732 | 5.372 | 1.10+002 | 1.11+002 | -0.8 |
| 73.149 | 5.461 | 1.08+002 | 1.08+002 | 0.1 |
| 78.649 | 5.539 | 1.07+002 | 1.06+002 | 1.1 |
| 84.276 | 5.715 | 1.04+002 | 1.03+002 | 0.6 |

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 430PM

| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
|---------------------|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| 26.822 | 1.496 | 9.14+001 | 9.17+001 | -0.4 |
| 28.305 | 1.470 | 9.28+001 | 9.53+001 | -2.7 |
| 29.751 | 1.421 | 9.61+001 | 9.84+001 | -2.4 |
| 31.148 | 1.373 | 9.93+001 | 1.01+002 | -1.8 |
| 32.492 | 1.316 | 1.04+002 | 1.04+002 | 0.4 |
| 33.774 | 1.247 | 1.10+002 | 1.06+002 | 3.7 |
| 35.019 | 1.244 | 1.10+002 | 1.07+002 | 2.4 |

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 27AUG68 135PM

| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
|---------------------|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| 78.252 | 2.003 | 1.05+002 | 1.06+002 | -0.5 |
| 80.278 | 2.048 | 1.03+002 | 1.05+002 | -2.0 |
| 82.328 | 2.053 | 1.03+002 | 1.04+002 | -1.2 |
| 84.386 | 2.064 | 1.02+002 | 1.03+002 | -1.0 |
| 86.452 | 2.069 | 1.02+002 | 1.02+002 | -0.1 |
| 88.521 | 2.068 | 1.02+002 | 1.01+002 | 0.8 |
| 90.602 | 2.094 | 1.01+002 | 1.00+002 | 0.6 |

Table 11 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 6SEPT68 1130AM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 206.823 | 5.222 | 8.25+001 | 8.13+001 | 1.4 |
| 212.090 | 5.312 | 8.09+001 | 8.10+001 | -0.1 |
| 217.401 | 5.311 | 8.10+001 | 8.07+001 | 0.4 |
| 222.737 | 5.359 | 8.02+001 | 8.03+001 | -0.2 |
| 228.104 | 5.375 | 8.01+001 | 7.99+001 | 0.2 |
| 233.494 | 5.404 | 7.97+001 | 7.95+001 | 0.1 |
| 238.926 | 5.461 | 7.89+001 | 7.91+001 | -0.3 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 7SEPT68 430 PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 233.559 | 12.173 | 8.08+001 | 7.95+001 | 1.6 |
| 245.889 | 12.487 | 7.86+001 | 7.86+001 | -0.1 |
| 258.409 | 12.554 | 7.82+001 | 7.77+001 | 0.8 |
| 271.078 | 12.783 | 7.67+001 | 7.66+001 | 0.1 |
| 283.913 | 12.887 | 7.63+001 | 7.56+001 | 1.0 |
| 296.899 | 13.084 | 7.51+001 | 7.45+001 | 0.8 |
| 310.118 | 13.354 | 7.37+001 | 7.35+001 | 0.3 |
| ----- | | | | |

Table 12 Electrical resistivity deviations for Armco iron, specimen 2.

| MEAN TEMPERATURE | TEMPERATURE RANGE | OBSERVED RESISTANCE | CALCULATED RESISTANCE | PERCENT DEVIATION | INTRINSIC RESISTANCE |
|---------------------|----------------------|------------------------|--------------------------|----------------------|-------------------------|
| 5.729 | 1.368 | 1.166-004 | 1.166-004 | -0.03 | 2.034-009 |
| 9.006 | 3.727 | 1.168-004 | 1.168-004 | -0.02 | 2.020-007 |
| 14.277 | 5.485 | 1.171-004 | 1.171-004 | 0.04 | 5.520-007 |
| 23.205 | 10.416 | 1.188-004 | 1.189-004 | -0.01 | 2.252-006 |
| 24.534 | 2.746 | 1.191-004 | 1.192-004 | -0.07 | 2.502-006 |
| 44.935 | 18.568 | 1.372-004 | 1.370-004 | 0.10 | 2.055-005 |
| 67.905 | 37.699 | 1.980-004 | 1.983-004 | -0.16 | 8.135-005 |
| 31.044 | 9.567 | 1.221-004 | 1.222-004 | -0.12 | 5.502-006 |
| 84.402 | 14.398 | 2.623-004 | 2.624-004 | -0.05 | 1.457-004 |
| 105.715 | 27.454 | 3.763-004 | 3.763-004 | -0.01 | 2.597-004 |
| 161.880 | 93.511 | 7.513-004 | 7.510-004 | 0.03 | 6.347-004 |
| 265.025 | 212.914 | 1.579-003 | 1.580-003 | -0.08 | 1.462-003 |
| 222.796 | 37.445 | 1.201-003 | 1.202-003 | -0.03 | 1.085-003 |
| 271.407 | 89.322 | 1.606-003 | 1.604-003 | 0.12 | 1.490-003 |
| 4.941 | 0.000 | 1.166-004 | 1.166-004 | 0.01 | 2.034-009 |
| 7.440 | 0.000 | 1.167-004 | 1.166-004 | 0.07 | 1.020-007 |
| 10.762 | 0.000 | 1.168-004 | 1.170-004 | -0.12 | 2.520-007 |
| 16.463 | 0.000 | 1.174-004 | 1.173-004 | 0.13 | 8.020-007 |
| 19.866 | 0.000 | 1.179-004 | 1.179-004 | 0.08 | 1.352-006 |
| 22.883 | 0.000 | 1.186-004 | 1.186-004 | -0.04 | 2.002-006 |
| 46.231 | 0.000 | 1.381-004 | 1.379-004 | 0.20 | 2.155-005 |
| 23.936 | 0.000 | 1.189-004 | 1.190-004 | -0.07 | 2.302-006 |
| 63.298 | 0.000 | 1.782-004 | 1.783-004 | -0.04 | 6.160-005 |
| 63.076 | 0.000 | 1.777-004 | 1.776-004 | 0.07 | 6.110-005 |
| 75.983 | 0.000 | 2.245-004 | 2.245-004 | -0.00 | 1.079-004 |
| 89.764 | 0.000 | 2.879-004 | 2.880-004 | -0.06 | 1.713-004 |
| 108.179 | 0.000 | 3.897-004 | 3.895-004 | 0.04 | 2.731-004 |
| 144.310 | 0.000 | 6.241-004 | 6.231-004 | 0.16 | 5.075-004 |
| 200.924 | 0.000 | 1.032-003 | 1.033-003 | -0.14 | 9.151-004 |
| 220.121 | 0.000 | 1.180-003 | 1.180-003 | 0.01 | 1.064-003 |

Table 13 Thermovoltage deviations for Armco iron, specimen 2.

| UPPER TEMPERATURE | LOWER TEMPERATURE | OBSERVED THERMOVOLTAGE | CALCULATED THERMOVOLTAGE | DEVIATION |
|----------------------|----------------------|---------------------------|-----------------------------|-----------|
| 6.378 | 5.010 | -0.03 | -0.03 | 0.01 |
| 10.719 | 6.992 | 0.13 | 0.18 | -0.04 |
| 16.821 | 11.336 | 0.51 | 0.40 | 0.11 |
| 28.033 | 17.616 | 3.60 | 3.71 | -0.11 |
| 25.873 | 23.127 | 1.04 | 1.15 | -0.11 |
| 54.051 | 35.483 | 47.20 | 46.99 | 0.21 |
| 87.134 | 49.435 | 241.42 | 241.65 | -0.23 |
| 35.641 | 26.074 | 8.19 | 8.15 | 0.04 |
| 91.649 | 77.251 | 129.98 | 129.81 | 0.17 |
| 119.591 | 92.137 | 318.51 | 318.18 | 0.33 |
| 209.535 | 116.024 | 1343.50 | 1343.64 | -0.15 |
| 374.600 | 161.685 | 2724.50 | 2724.48 | 0.02 |
| 241.657 | 204.212 | 544.20 | 543.87 | 0.33 |
| 316.795 | 227.472 | 1174.06 | 1174.17 | -0.11 |

Table 14 Thermal conductivity deviations for Armco iron, specimen 2a.

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 9 MAR 69 900 AM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 88.001 | 3.756 | 9.92+001 | 9.91+001 | 0.1 |
| 91.803 | 3.846 | 9.66+001 | 9.77+001 | -1.1 |
| 95.671 | 3.891 | 9.56+001 | 9.64+001 | -0.8 |
| 99.578 | 3.922 | 9.47+001 | 9.52+001 | -0.5 |
| 103.519 | 3.960 | 9.41+001 | 9.41+001 | 0.0 |
| 107.488 | 3.979 | 9.36+001 | 9.30+001 | 0.6 |
| 111.490 | 4.025 | 9.26+001 | 9.20+001 | 0.7 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 1020 AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 92.869 | 8.591 | 9.76+001 | 9.74+001 | 0.2 |
| 101.615 | 8.902 | 9.40+001 | 9.46+001 | -0.6 |
| 110.620 | 9.108 | 9.20+001 | 9.22+001 | -0.2 |
| 119.815 | 9.281 | 9.01+001 | 9.01+001 | -0.0 |
| 129.171 | 9.433 | 8.89+001 | 8.84+001 | 0.5 |
| 138.666 | 9.556 | 8.77+001 | 8.70+001 | 0.8 |
| 148.300 | 9.712 | 8.64+001 | 8.59+001 | 0.6 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 500 PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 115.780 | 17.746 | 9.17+001 | 9.10+001 | 0.8 |
| 133.920 | 18.533 | 8.76+001 | 8.77+001 | -0.1 |
| 152.704 | 19.036 | 8.54+001 | 8.54+001 | 0.0 |
| 171.937 | 19.430 | 8.36+001 | 8.36+001 | -0.1 |
| 191.565 | 19.826 | 8.21+001 | 8.21+001 | -0.0 |
| 211.576 | 20.196 | 8.05+001 | 8.05+001 | 0.0 |
| 231.993 | 20.639 | 7.89+001 | 7.89+001 | 0.1 |

Table 14 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 11 MAR 69 440 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 135.945 | 4.224 | 8.83+001 | 8.74+001 | 1.0 |
| 140.226 | 4.337 | 8.58+001 | 8.68+001 | -1.3 |
| 144.562 | 4.336 | 8.59+001 | 8.63+001 | -0.5 |
| 148.892 | 4.323 | 8.60+001 | 8.58+001 | 0.2 |
| 153.229 | 4.351 | 8.57+001 | 8.53+001 | 0.4 |
| 157.584 | 4.359 | 8.55+001 | 8.49+001 | 0.7 |
| 161.969 | 4.411 | 8.46+001 | 8.45+001 | 0.1 |

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 12 MAR 69 1007 AM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 141.419 | 9.589 | 8.75+001 | 8.67+001 | 0.9 |
| 151.133 | 9.839 | 8.51+001 | 8.56+001 | -0.6 |
| 161.016 | 9.927 | 8.44+001 | 8.46+001 | -0.2 |
| 170.979 | 10.000 | 8.37+001 | 8.37+001 | -0.0 |
| 181.042 | 10.127 | 8.28+001 | 8.29+001 | -0.1 |
| 191.213 | 10.214 | 8.21+001 | 8.21+001 | -0.0 |
| 201.500 | 10.359 | 8.11+001 | 8.13+001 | -0.3 |

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 25 MAR 69 345 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 198.547 | 3.502 | 8.15+001 | 8.15+001 | -0.0 |
| 202.066 | 3.536 | 8.06+001 | 8.13+001 | -0.9 |
| 205.604 | 3.541 | 8.05+001 | 8.10+001 | -0.6 |
| 209.148 | 3.548 | 8.03+001 | 8.07+001 | -0.6 |
| 212.699 | 3.553 | 8.03+001 | 8.04+001 | -0.1 |
| 216.257 | 3.561 | 8.01+001 | 8.01+001 | -0.0 |
| 219.831 | 3.587 | 7.96+001 | 7.99+001 | -0.3 |

Table 14 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 12 MAR 69 540 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 21.536 | 0.736 | 7.00+001 | 7.02+001 | -0.4 |
| 22.265 | 0.722 | 7.12+001 | 7.23+001 | -1.5 |
| 22.982 | 0.713 | 7.21+001 | 7.44+001 | -3.1 |
| 23.678 | 0.679 | 7.57+001 | 7.63+001 | -0.8 |
| 24.350 | 0.665 | 7.75+001 | 7.81+001 | -0.8 |
| 25.000 | 0.636 | 8.09+001 | 7.98+001 | 1.4 |
| 25.628 | 0.619 | 8.33+001 | 8.14+001 | 2.3 |

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 13 MAR 69 1015 AM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 23.982 | 1.332 | 7.70+001 | 7.71+001 | -0.1 |
| 25.293 | 1.290 | 7.93+001 | 8.05+001 | -1.5 |
| 26.569 | 1.261 | 8.12+001 | 8.37+001 | -3.0 |
| 27.795 | 1.192 | 8.58+001 | 8.65+001 | -0.8 |
| 28.970 | 1.158 | 8.86+001 | 8.91+001 | -0.6 |
| 30.099 | 1.100 | 9.31+001 | 9.14+001 | 1.9 |
| 31.184 | 1.070 | 9.59+001 | 9.34+001 | 2.6 |

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 13 MAR 69 1215 PM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 28.826 | 3.418 | 8.91+001 | 8.88+001 | 0.3 |
| 32.148 | 3.226 | 9.41+001 | 9.52+001 | -1.1 |
| 35.314 | 3.106 | 9.79+001 | 1.00+002 | -2.2 |
| 38.341 | 2.948 | 1.03+002 | 1.04+002 | -0.6 |
| 41.253 | 2.875 | 1.06+002 | 1.06+002 | -0.3 |
| 44.075 | 2.769 | 1.10+002 | 1.08+002 | 1.7 |
| 46.822 | 2.725 | 1.12+002 | 1.09+002 | 2.4 |

Table 14 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 13 MAR 69 300 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 36.201 | 6.333 | 1.02+002 | 1.01+002 | 0.4 |
| 42.397 | 6.060 | 1.06+002 | 1.07+002 | -1.0 |
| 48.399 | 5.943 | 1.08+002 | 1.10+002 | -1.3 |
| 54.298 | 5.855 | 1.10+002 | 1.10+002 | -0.4 |
| 60.168 | 5.885 | 1.09+002 | 1.09+002 | 0.2 |
| 66.065 | 5.909 | 1.09+002 | 1.07+002 | 1.3 |
| 72.043 | 6.049 | 1.06+002 | 1.05+002 | 1.1 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 13 MAR 69 520 PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 48.480 | 7.184 | 1.11+002 | 1.10+002 | 0.9 |
| 55.708 | 7.270 | 1.09+002 | 1.10+002 | -0.7 |
| 63.045 | 7.403 | 1.07+002 | 1.08+002 | -1.0 |
| 70.526 | 7.558 | 1.05+002 | 1.06+002 | -0.9 |
| 78.179 | 7.748 | 1.03+002 | 1.03+002 | -0.3 |
| 86.006 | 7.907 | 1.00+002 | 9.98+001 | 0.6 |
| 94.033 | 8.148 | 9.76+001 | 9.70+001 | 0.6 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(2A) 7 MAR 69 500 PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 78.942 | 1.412 | 1.03+002 | 1.03+002 | 0.0 |
| 80.364 | 1.433 | 1.01+002 | 1.02+002 | -1.2 |
| 81.801 | 1.440 | 1.00+002 | 1.01+002 | -1.0 |
| 83.243 | 1.444 | 1.00+002 | 1.01+002 | -0.8 |
| 84.690 | 1.448 | 9.99+001 | 1.00+002 | -0.4 |
| 86.136 | 1.444 | 1.00+002 | 9.98+001 | 0.4 |
| 87.584 | 1.452 | 9.98+001 | 9.92+001 | 0.5 |
| ----- | | | | |

Table 14 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 433PM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 5.048 | 0.317 | 1.65+001 | 1.63+001 | 1.1 |
| 5.355 | 0.296 | 1.76+001 | 1.74+001 | 0.9 |
| 5.647 | 0.289 | 1.81+001 | 1.85+001 | -2.1 |
| 5.926 | 0.269 | 1.94+001 | 1.95+001 | -0.5 |
| 6.191 | 0.261 | 2.01+001 | 2.04+001 | -1.8 |
| 6.441 | 0.239 | 2.19+001 | 2.13+001 | 2.8 |
| 6.677 | 0.233 | 2.24+001 | 2.21+001 | 1.5 |

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 545 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 6.337 | 0.584 | 2.08+001 | 2.09+001 | -0.5 |
| 6.894 | 0.530 | 2.29+001 | 2.28+001 | 0.2 |
| 7.413 | 0.509 | 2.39+001 | 2.46+001 | -3.1 |
| 7.900 | 0.465 | 2.61+001 | 2.62+001 | -0.7 |
| 8.355 | 0.444 | 2.74+001 | 2.77+001 | -1.3 |
| 8.780 | 0.407 | 2.99+001 | 2.91+001 | 2.4 |
| 9.178 | 0.389 | 3.12+001 | 3.05+001 | 2.5 |

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 715 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 8.206 | 1.220 | 2.72+001 | 2.72+001 | 0.0 |
| 9.355 | 1.078 | 3.08+001 | 3.10+001 | -0.9 |
| 10.386 | 0.986 | 3.37+001 | 3.44+001 | -2.3 |
| 11.321 | 0.883 | 3.75+001 | 3.75+001 | 0.1 |
| 12.176 | 0.827 | 4.02+001 | 4.03+001 | -0.3 |
| 12.966 | 0.753 | 4.41+001 | 4.29+001 | 2.7 |
| 13.698 | 0.711 | 4.68+001 | 4.54+001 | 3.1 |

Table 14 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 810 PM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 11.955 | 2.286 | 3.99+001 | 3.96+001 | 0.9 |
| 14.080 | 1.963 | 4.64+001 | 4.66+001 | -0.5 |
| 15.947 | 1.771 | 5.15+001 | 5.28+001 | -2.4 |
| 17.615 | 1.565 | 5.82+001 | 5.81+001 | 0.1 |
| 19.127 | 1.459 | 6.26+001 | 6.29+001 | -0.6 |
| 20.521 | 1.328 | 6.87+001 | 6.72+001 | 2.2 |
| 21.811 | 1.252 | 7.30+001 | 7.10+001 | 2.7 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1045 AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 14.527 | 2.806 | 4.83+001 | 4.81+001 | 0.5 |
| 17.137 | 2.415 | 5.60+001 | 5.66+001 | -1.1 |
| 19.435 | 2.180 | 6.21+001 | 6.39+001 | -2.8 |
| 21.494 | 1.937 | 6.98+001 | 7.01+001 | -0.4 |
| 23.366 | 1.809 | 7.50+001 | 7.54+001 | -0.6 |
| 25.100 | 1.659 | 8.17+001 | 8.00+001 | 2.0 |
| 26.715 | 1.571 | 8.63+001 | 8.40+001 | 2.7 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1200 NOON | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 16.353 | 0.740 | 5.41+001 | 5.41+001 | 0.0 |
| 17.080 | 0.715 | 5.58+001 | 5.64+001 | -1.1 |
| 17.789 | 0.701 | 5.70+001 | 5.87+001 | -3.0 |
| 18.468 | 0.657 | 6.08+001 | 6.09+001 | -0.2 |
| 19.117 | 0.641 | 6.24+001 | 6.29+001 | -0.8 |
| 19.740 | 0.605 | 6.61+001 | 6.48+001 | 1.9 |
| 20.335 | 0.585 | 6.85+001 | 6.66+001 | 2.7 |
| ----- | | | | |

Table 14 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 26 MAR 69 1200 NOON | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 212.561 | 6.947 | 8.06+001 | 8.04+001 | 0.1 |
| 219.559 | 7.049 | 7.92+001 | 7.99+001 | -0.8 |
| 226.623 | 7.078 | 7.90+001 | 7.93+001 | -0.4 |
| 233.717 | 7.111 | 7.85+001 | 7.87+001 | -0.3 |
| 240.846 | 7.146 | 7.83+001 | 7.81+001 | 0.2 |
| 248.015 | 7.192 | 7.78+001 | 7.76+001 | 0.3 |
| 255.244 | 7.267 | 7.71+001 | 7.70+001 | 0.1 |

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 26 MAR 69 715 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 218.594 | 12.985 | 8.00+001 | 8.00+001 | 0.1 |
| 231.706 | 13.240 | 7.83+001 | 7.89+001 | -0.7 |
| 245.013 | 13.375 | 7.76+001 | 7.78+001 | -0.2 |
| 258.456 | 13.512 | 7.67+001 | 7.67+001 | -0.0 |
| 272.039 | 13.653 | 7.61+001 | 7.58+001 | 0.4 |
| 285.779 | 13.829 | 7.51+001 | 7.50+001 | 0.2 |
| 299.737 | 14.086 | 7.38+001 | 7.45+001 | -0.8 |

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 27 MAR 69 445 PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 235.266 | 2.638 | 7.95+001 | 7.86+001 | 1.2 |
| 237.935 | 2.700 | 7.75+001 | 7.84+001 | -1.1 |
| 240.629 | 2.688 | 7.80+001 | 7.82+001 | -0.2 |
| 243.307 | 2.668 | 7.84+001 | 7.79+001 | 0.6 |
| 245.976 | 2.671 | 7.85+001 | 7.77+001 | 1.0 |
| 248.654 | 2.683 | 7.81+001 | 7.75+001 | 0.8 |
| 251.360 | 2.729 | 7.69+001 | 7.73+001 | -0.5 |

Table 14 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 3 APRIL 69 430 PM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 277.356 | 2.718 | 7.63+001 | 7.55+001 | 1.1 |
| 280.090 | 2.749 | 7.52+001 | 7.53+001 | -0.1 |
| 282.841 | 2.753 | 7.52+001 | 7.51+001 | 0.1 |
| 285.596 | 2.758 | 7.50+001 | 7.50+001 | -0.1 |
| 288.356 | 2.762 | 7.50+001 | 7.49+001 | 0.2 |
| 291.125 | 2.776 | 7.46+001 | 7.48+001 | -0.2 |
| 293.911 | 2.796 | 7.42+001 | 7.46+001 | -0.6 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 4 APRIL 69 920 AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 277.631 | 2.748 | 7.63+001 | 7.54+001 | 1.2 |
| 280.395 | 2.781 | 7.53+001 | 7.53+001 | -0.0 |
| 283.178 | 2.785 | 7.52+001 | 7.51+001 | 0.1 |
| 285.966 | 2.790 | 7.50+001 | 7.50+001 | 0.0 |
| 288.758 | 2.795 | 7.50+001 | 7.49+001 | 0.2 |
| 291.561 | 2.811 | 7.46+001 | 7.47+001 | -0.2 |
| 294.382 | 2.831 | 7.42+001 | 7.46+001 | -0.6 |
| ----- | | | | |

Table 15 Electrical resistivity deviations for Armco iron, specimen 2a.

| MEAN TEMPERATURE | TEMPERATURE RANGE | OBSERVED RESISTANCE | CALCULATED RESISTANCE | PERCENT DEVIATION | INTRINSIC RESISTANCE |
|---------------------|----------------------|------------------------|--------------------------|----------------------|-------------------------|
| 5.898 | 1.904 | 1.292-004 | 1.292-004 | -0.00 | 5.572-008 |
| 7.837 | 3.327 | 1.293-004 | 1.293-004 | 0.02 | 1.557-007 |
| 11.158 | 6.458 | 1.295-004 | 1.296-004 | -0.05 | 3.557-007 |
| 17.293 | 11.624 | 1.301-004 | 1.301-004 | 0.03 | 1.006-006 |
| 21.110 | 14.377 | 1.309-004 | 1.309-004 | -0.04 | 1.756-006 |
| 18.412 | 4.644 | 1.302-004 | 1.302-004 | 0.07 | 1.106-006 |
| 23.634 | 4.770 | 1.314-004 | 1.315-004 | -0.07 | 2.256-006 |
| 27.699 | 8.402 | 1.329-004 | 1.330-004 | -0.11 | 3.756-006 |
| 38.111 | 21.067 | 1.410-004 | 1.409-004 | 0.05 | 1.186-005 |
| 54.224 | 42.033 | 1.719-004 | 1.716-004 | 0.12 | 4.271-005 |
| 70.853 | 53.219 | 2.249-004 | 2.249-004 | 0.01 | 9.576-005 |
| 83.251 | 10.074 | 2.680-004 | 2.682-004 | -0.08 | 1.389-004 |
| 99.650 | 27.379 | 3.532-004 | 3.534-004 | -0.05 | 2.241-004 |
| 120.150 | 64.582 | 4.793-004 | 4.793-004 | -0.01 | 3.502-004 |
| 172.780 | 135.405 | 8.452-004 | 8.446-004 | 0.07 | 7.161-004 |
| 148.915 | 30.341 | 6.669-004 | 6.664-004 | 0.07 | 5.378-004 |
| 171.185 | 70.055 | 8.265-004 | 8.260-004 | 0.06 | 6.974-004 |
| 209.164 | 24.828 | 1.105-003 | 1.106-003 | -0.10 | 9.759-004 |
| 233.794 | 49.790 | 1.299-003 | 1.299-003 | 0.03 | 1.170-003 |
| 258.759 | 94.678 | 1.508-003 | 1.508-003 | 0.01 | 1.379-003 |
| 243.303 | 18.777 | 1.376-003 | 1.374-003 | 0.11 | 1.246-003 |
| 285.611 | 19.312 | 1.733-003 | 1.734-003 | -0.04 | 1.604-003 |
| 285.981 | 19.540 | 1.737-003 | 1.737-003 | -0.03 | 1.608-003 |
| 4.132 | 0.000 | 1.291-004 | 1.292-004 | -0.00 | 5.721-009 |
| 19.818 | 0.000 | 1.305-004 | 1.304-004 | 0.06 | 1.356-006 |
| 75.934 | 0.000 | 2.358-004 | 2.358-004 | -0.01 | 1.067-004 |
| 84.195 | 0.000 | 2.722-004 | 2.724-004 | -0.06 | 1.431-004 |
| 131.684 | 0.000 | 5.494-004 | 5.489-004 | 0.09 | 4.203-004 |
| 192.760 | 0.000 | 9.801-004 | 9.820-004 | -0.20 | 8.509-004 |
| 273.215 | 0.000 | 1.625-003 | 1.624-003 | 0.04 | 1.496-003 |

Table 16 Thermovoltage deviations for Armco iron, specimen 2a.

| UPPER TEMPERATURE | LOWER TEMPERATURE | OBSERVED THERMOVOLTAGE | CALCULATED THERMOVOLTAGE | DEVIATION |
|----------------------|----------------------|---------------------------|-----------------------------|-----------|
| 6.793 | 4.889 | 0.01 | -0.13 | 0.14 |
| 9.372 | 6.045 | 0.10 | 0.24 | -0.14 |
| 14.053 | 7.595 | 0.43 | 0.48 | -0.05 |
| 22.437 | 10.813 | 1.99 | 1.84 | 0.15 |
| 27.501 | 13.124 | 4.21 | 4.21 | 0.00 |
| 20.627 | 15.983 | 0.84 | 0.88 | -0.04 |
| 25.937 | 21.168 | 1.82 | 1.99 | -0.17 |
| 31.719 | 23.316 | 5.37 | 5.59 | -0.22 |
| 48.185 | 27.118 | 35.68 | 35.66 | 0.02 |
| 75.068 | 33.034 | 175.46 | 175.26 | 0.20 |
| 98.108 | 44.888 | 368.80 | 369.03 | -0.23 |
| 88.310 | 78.236 | 89.71 | 89.65 | 0.06 |
| 113.503 | 86.123 | 300.24 | 300.21 | 0.03 |
| 153.156 | 88.574 | 815.92 | 815.81 | 0.11 |
| 242.313 | 106.908 | 1922.36 | 1922.21 | 0.15 |
| 164.175 | 133.833 | 432.88 | 433.24 | -0.36 |
| 206.680 | 136.624 | 1023.47 | 1023.63 | -0.16 |
| 221.625 | 196.796 | 364.64 | 364.50 | 0.14 |
| 258.878 | 209.087 | 708.45 | 708.36 | 0.09 |
| 306.779 | 212.101 | 1276.16 | 1276.24 | -0.08 |
| 252.724 | 233.947 | 263.21 | 263.59 | -0.38 |
| 295.309 | 275.998 | 245.31 | 245.17 | 0.14 |
| 295.797 | 276.257 | 247.90 | 247.79 | 0.11 |

Table 17 Thermal conductivity deviations for Armco iron, specimen 4.

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68 1140AM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 78.980 | 0.909 | 1.02+002 | 1.02+002 | -0.1 |
| 79.895 | 0.923 | 1.01+002 | 1.02+002 | -1.2 |
| 80.816 | 0.919 | 1.01+002 | 1.01+002 | -0.3 |
| 81.739 | 0.926 | 1.00+002 | 1.01+002 | -0.6 |
| 82.663 | 0.923 | 1.01+002 | 1.01+002 | 0.3 |
| 83.588 | 0.928 | 1.00+002 | 1.00+002 | -0.0 |
| 84.519 | 0.934 | 9.96+001 | 1.00+002 | -0.4 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68 540PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 87.322 | 2.880 | 9.89+001 | 9.89+001 | -0.0 |
| 90.234 | 2.946 | 9.68+001 | 9.78+001 | -1.1 |
| 93.186 | 2.957 | 9.66+001 | 9.68+001 | -0.2 |
| 96.160 | 2.990 | 9.56+001 | 9.58+001 | -0.2 |
| 99.156 | 3.002 | 9.54+001 | 9.49+001 | 0.6 |
| 102.174 | 3.035 | 9.42+001 | 9.39+001 | 0.3 |
| 105.226 | 3.067 | 9.32+001 | 9.31+001 | 0.1 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 12 DEC 68 1130AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 105.697 | 7.526 | 9.36+001 | 9.29+001 | 0.7 |
| 113.346 | 7.772 | 9.07+001 | 9.10+001 | -0.3 |
| 121.163 | 7.863 | 8.98+001 | 8.94+001 | 0.5 |
| 129.090 | 7.990 | 8.85+001 | 8.80+001 | 0.5 |
| 137.118 | 8.065 | 8.78+001 | 8.69+001 | 1.1 |
| 145.243 | 8.186 | 8.64+001 | 8.59+001 | 0.6 |
| 153.483 | 8.294 | 8.52+001 | 8.51+001 | 0.2 |

Table 17 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 13 DEC 68 915AM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 160.065 | 15.373 | 8.54+001 | 8.45+001 | 1.0 |
| 175.714 | 15.923 | 8.25+001 | 8.34+001 | -1.0 |
| 191.731 | 16.111 | 8.17+001 | 8.23+001 | -0.8 |
| 207.962 | 16.352 | 8.06+001 | 8.12+001 | -0.8 |
| 224.416 | 16.556 | 7.97+001 | 8.00+001 | -0.4 |
| 241.116 | 16.843 | 7.83+001 | 7.87+001 | -0.5 |
| 258.099 | 17.124 | 7.69+001 | 7.72+001 | -0.3 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 13 DEC 68 835PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 208.349 | 16.131 | 8.16+001 | 8.12+001 | 0.5 |
| 224.806 | 16.785 | 7.85+001 | 8.00+001 | -1.9 |
| 241.665 | 16.934 | 7.80+001 | 7.86+001 | -0.8 |
| 258.718 | 17.172 | 7.69+001 | 7.71+001 | -0.2 |
| 276.003 | 17.399 | 7.61+001 | 7.56+001 | 0.6 |
| 293.594 | 17.782 | 7.44+001 | 7.42+001 | 0.2 |
| 311.567 | 18.165 | 7.27+001 | 7.31+001 | -0.5 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 19 DEC 68 500PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 205.638 | 5.156 | 8.23+001 | 8.14+001 | 1.0 |
| 210.852 | 5.272 | 8.05+001 | 8.10+001 | -0.6 |
| 216.128 | 5.280 | 8.06+001 | 8.07+001 | -0.1 |
| 221.429 | 5.321 | 8.00+001 | 8.03+001 | -0.3 |
| 226.759 | 5.339 | 7.99+001 | 7.98+001 | 0.0 |
| 232.120 | 5.381 | 7.92+001 | 7.94+001 | -0.3 |
| 237.524 | 5.427 | 7.84+001 | 7.90+001 | -0.7 |
| ----- | | | | |

Table 17 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1135 AM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 5.427 | 0.228 | 1.80+001 | 1.76+001 | 2.4 |
| 5.650 | 0.219 | 1.88+001 | 1.84+001 | 2.1 |
| 5.866 | 0.212 | 1.94+001 | 1.91+001 | 1.5 |
| 6.075 | 0.207 | 1.99+001 | 1.99+001 | 0.4 |
| 6.279 | 0.200 | 2.07+001 | 2.06+001 | 0.5 |
| 6.475 | 0.193 | 2.14+001 | 2.12+001 | 0.7 |
| 6.669 | 0.194 | 2.12+001 | 2.19+001 | -3.0 |

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1225PM | | | | |
|--|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 7.211 | 0.542 | 2.35+001 | 2.37+001 | -0.7 |
| 7.732 | 0.501 | 2.55+001 | 2.54+001 | 0.2 |
| 8.219 | 0.473 | 2.70+001 | 2.70+001 | 0.0 |
| 8.678 | 0.446 | 2.87+001 | 2.85+001 | 0.6 |
| 9.113 | 0.423 | 3.03+001 | 3.00+001 | 1.0 |
| 9.526 | 0.403 | 3.18+001 | 3.13+001 | 1.4 |
| 9.922 | 0.391 | 3.27+001 | 3.26+001 | 0.4 |

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 130PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 10.579 | 0.884 | 3.46+001 | 3.48+001 | -0.6 |
| 11.428 | 0.815 | 3.76+001 | 3.76+001 | 0.0 |
| 12.216 | 0.761 | 4.03+001 | 4.01+001 | 0.3 |
| 12.955 | 0.717 | 4.28+001 | 4.26+001 | 0.5 |
| 13.653 | 0.677 | 4.54+001 | 4.49+001 | 1.1 |
| 14.314 | 0.645 | 4.76+001 | 4.70+001 | 1.2 |
| 14.947 | 0.622 | 4.93+001 | 4.91+001 | 0.5 |

Table 17 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 505PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 5.449 | 0.238 | 1.73+001 | 1.77+001 | -2.3 |
| 5.679 | 0.223 | 1.85+001 | 1.85+001 | -0.2 |
| 5.899 | 0.216 | 1.91+001 | 1.93+001 | -0.9 |
| 6.111 | 0.209 | 1.98+001 | 2.00+001 | -1.1 |
| 6.317 | 0.203 | 2.03+001 | 2.07+001 | -1.6 |
| 6.514 | 0.191 | 2.16+001 | 2.14+001 | 0.9 |
| 6.705 | 0.190 | 2.16+001 | 2.20+001 | -1.6 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 540PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 17.565 | 1.711 | 5.72+001 | 5.75+001 | -0.6 |
| 19.207 | 1.572 | 6.23+001 | 6.27+001 | -0.6 |
| 20.724 | 1.462 | 6.71+001 | 6.72+001 | -0.2 |
| 22.142 | 1.375 | 7.14+001 | 7.14+001 | 0.1 |
| 23.477 | 1.295 | 7.60+001 | 7.51+001 | 1.2 |
| 24.743 | 1.237 | 7.94+001 | 7.84+001 | 1.2 |
| 25.961 | 1.199 | 8.18+001 | 8.15+001 | 0.4 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 600PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 17.580 | 1.718 | 5.69+001 | 5.76+001 | -1.1 |
| 19.227 | 1.577 | 6.21+001 | 6.27+001 | -1.0 |
| 20.750 | 1.468 | 6.68+001 | 6.73+001 | -0.7 |
| 22.177 | 1.386 | 7.08+001 | 7.15+001 | -0.9 |
| 23.516 | 1.292 | 7.61+001 | 7.52+001 | 1.2 |
| 24.782 | 1.241 | 7.92+001 | 7.85+001 | 0.8 |
| 26.005 | 1.204 | 8.15+001 | 8.16+001 | -0.1 |
| ----- | | | | |

Table 17 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 635PM | | | | |
|---|---------------------------|-------------------------------------|---------------------------------------|----------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 14.083 | 1.051 | 4.59+001 | 4.63+001 | -0.7 |
| 15.096 | 0.980 | 4.93+001 | 4.96+001 | -0.5 |
| 16.051 | 0.924 | 5.24+001 | 5.27+001 | -0.5 |
| 16.951 | 0.876 | 5.53+001 | 5.56+001 | -0.5 |
| 17.802 | 0.827 | 5.87+001 | 5.83+001 | 0.7 |
| 18.612 | 0.791 | 6.13+001 | 6.08+001 | 0.8 |
| 19.391 | 0.767 | 6.32+001 | 6.32+001 | -0.1 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 1140AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 21.850 | 0.273 | 6.95+001 | 7.05+001 | -1.4 |
| 22.121 | 0.270 | 7.05+001 | 7.13+001 | -1.2 |
| 22.389 | 0.266 | 7.15+001 | 7.21+001 | -0.8 |
| 22.654 | 0.263 | 7.23+001 | 7.28+001 | -0.7 |
| 22.914 | 0.258 | 7.39+001 | 7.35+001 | 0.4 |
| 23.170 | 0.253 | 7.53+001 | 7.42+001 | 1.3 |
| 23.424 | 0.254 | 7.50+001 | 7.49+001 | 0.1 |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 115PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 23.759 | 0.525 | 7.48+001 | 7.58+001 | -1.4 |
| 24.278 | 0.513 | 7.66+001 | 7.72+001 | -0.8 |
| 24.787 | 0.504 | 7.81+001 | 7.86+001 | -0.6 |
| 25.288 | 0.498 | 7.91+001 | 7.98+001 | -0.9 |
| 25.777 | 0.480 | 8.23+001 | 8.11+001 | 1.5 |
| 26.255 | 0.477 | 8.27+001 | 8.22+001 | 0.6 |
| 26.729 | 0.470 | 8.38+001 | 8.34+001 | 0.5 |

Table 17 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 230PM | | | | |
|--|------------------------|-------------------------------|---------------------------------|-------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 28.203 | 1.423 | 8.63+001 | 8.67+001 | -0.5 |
| 29.605 | 1.381 | 8.90+001 | 8.97+001 | -0.7 |
| 30.964 | 1.337 | 9.22+001 | 9.23+001 | -0.1 |
| 32.283 | 1.302 | 9.47+001 | 9.47+001 | 0.0 |
| 33.563 | 1.258 | 9.82+001 | 9.68+001 | 1.4 |
| 34.811 | 1.239 | 9.96+001 | 9.86+001 | 0.9 |
| 36.043 | 1.224 | 1.01+002 | 1.00+002 | 0.4 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 455PM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 39.555 | 3.522 | 1.04+002 | 1.04+002 | -0.3 |
| 43.044 | 3.456 | 1.06+002 | 1.07+002 | -0.9 |
| 46.460 | 3.375 | 1.09+002 | 1.08+002 | 0.1 |
| 49.824 | 3.353 | 1.09+002 | 1.09+002 | 0.1 |
| 53.154 | 3.306 | 1.11+002 | 1.10+002 | 1.4 |
| 56.473 | 3.332 | 1.10+002 | 1.09+002 | 0.7 |
| 59.823 | 3.368 | 1.09+002 | 1.09+002 | 0.1 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 18DEC68 1150AM | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | CALCULATED THERMAL CONDUCTIVITY | PERCENT DEVIATION |
| 60.412 | 4.981 | 1.09+002 | 1.09+002 | 0.2 |
| 65.465 | 5.124 | 1.06+002 | 1.07+002 | -1.2 |
| 70.621 | 5.190 | 1.05+002 | 1.05+002 | -0.6 |
| 75.858 | 5.284 | 1.03+002 | 1.03+002 | -0.4 |
| 81.171 | 5.343 | 1.02+002 | 1.01+002 | 0.7 |
| 86.585 | 5.484 | 9.93+001 | 9.92+001 | 0.1 |
| 92.133 | 5.612 | 9.69+001 | 9.72+001 | -0.2 |
| ----- | | | | |

Table 17 (Cont.)

| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(4) | | | | |
|---|---------------------------|-------------------------------------|---|--------------------------------|
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | 20DEC 68 CALCULATED THERMAL CONDUCTIVITY | 1025AM PERCENT DEVIATION |
| 246.036 | 12.423 | 7.94+001 | 7.82+001 | 1.4 |
| 258.676 | 12.858 | 7.68+001 | 7.71+001 | -0.4 |
| 271.589 | 12.968 | 7.63+001 | 7.60+001 | 0.4 |
| 284.644 | 13.141 | 7.53+001 | 7.49+001 | 0.6 |
| 297.864 | 13.300 | 7.45+001 | 7.39+001 | 0.9 |
| 311.287 | 13.546 | 7.31+001 | 7.31+001 | 0.1 |
| 324.952 | 13.782 | 7.18+001 | 7.25+001 | -1.0 |
| ----- | | | | |
| THERMAL CONDUCTIVITY DATA FOR ARMC0 IRON(4) | | | | |
| MEAN TEMPERATURE | TEMPERATURE DIFFERENCE | OBSERVED THERMAL CONDUCTIVITY | 20DEC 68 CALCULATED THERMAL CONDUCTIVITY | 340PM PERCENT DEVIATION |
| 226.641 | 7.974 | 8.09+001 | 7.98+001 | 1.3 |
| 234.731 | 8.205 | 7.87+001 | 7.92+001 | -0.6 |
| 242.951 | 8.236 | 7.86+001 | 7.85+001 | 0.1 |
| 251.227 | 8.316 | 7.79+001 | 7.78+001 | 0.1 |
| 259.564 | 8.357 | 7.76+001 | 7.70+001 | 0.8 |
| 267.967 | 8.449 | 7.67+001 | 7.63+001 | 0.5 |
| 276.464 | 8.545 | 7.58+001 | 7.56+001 | 0.3 |
| ----- | | | | |

Table 18 Electrical resistivity deviations for Armco iron, specimen 4.

| MEAN TEMPERATURE | TEMPERATURE RANGE | OBSERVED RESISTANCE | CALCULATED RESISTANCE | PERCENT DEVIATION | INTRINSIC RESISTANCE |
|---------------------|----------------------|------------------------|--------------------------|----------------------|-------------------------|
| 6.063 | 1.452 | 1.303-004 | 1.303-004 | -0.01 | -4.826-008 |
| 8.629 | 3.178 | 1.304-004 | 1.304-004 | 0.05 | 1.017-007 |
| 12.870 | 5.121 | 1.307-004 | 1.308-004 | -0.06 | 3.517-007 |
| 6.096 | 1.470 | 1.303-004 | 1.303-004 | 0.00 | -4.826-008 |
| 21.974 | 9.850 | 1.322-004 | 1.322-004 | 0.02 | 1.852-006 |
| 22.005 | 9.885 | 1.322-004 | 1.322-004 | 0.01 | 1.852-006 |
| 16.855 | 6.218 | 1.312-004 | 1.311-004 | 0.07 | 8.517-007 |
| 22.646 | 1.838 | 1.323-004 | 1.323-004 | -0.01 | 1.902-006 |
| 25.268 | 3.468 | 1.330-004 | 1.331-004 | -0.08 | 2.652-006 |
| 32.210 | 9.164 | 1.365-004 | 1.366-004 | -0.05 | 6.152-006 |
| 49.762 | 23.713 | 1.600-004 | 1.598-004 | 0.11 | 2.965-005 |
| 76.035 | 37.016 | 2.427-004 | 2.429-004 | -0.12 | 1.123-004 |
| 81.743 | 6.461 | 2.636-004 | 2.639-004 | -0.11 | 1.333-004 |
| 96.208 | 20.877 | 3.373-004 | 3.371-004 | 0.05 | 2.070-004 |
| 129.306 | 55.696 | 5.409-004 | 5.405-004 | 0.08 | 4.106-004 |
| 208.443 | 114.282 | 1.116-003 | 1.114-003 | 0.16 | 9.855-004 |
| 259.243 | 120.367 | 1.527-003 | 1.525-003 | 0.12 | 1.397-003 |
| 221.493 | 37.178 | 1.208-003 | 1.209-003 | -0.11 | 1.078-003 |
| 285.007 | 92.018 | 1.744-003 | 1.746-003 | -0.09 | 1.614-003 |
| 251.364 | 58.082 | 1.452-003 | 1.451-003 | 0.04 | 1.321-003 |
| 4.394 | 0.000 | 1.303-004 | 1.303-004 | -0.00 | -4.826-008 |
| 9.696 | 0.000 | 1.305-004 | 1.306-004 | -0.06 | 1.517-007 |
| 15.786 | 0.000 | 1.310-004 | 1.309-004 | 0.04 | 6.517-007 |
| 20.069 | 0.000 | 1.317-004 | 1.316-004 | 0.03 | 1.302-006 |
| 19.878 | 0.000 | 1.316-004 | 1.316-004 | 0.02 | 1.252-006 |
| 26.745 | 0.000 | 1.336-004 | 1.336-004 | -0.07 | 3.202-006 |
| 35.938 | 0.000 | 1.392-004 | 1.391-004 | 0.03 | 8.802-006 |
| 55.386 | 0.000 | 1.703-004 | 1.701-004 | 0.12 | 3.995-005 |
| 77.113 | 0.000 | 2.429-004 | 2.434-004 | -0.17 | 1.126-004 |
| 75.738 | 0.000 | 2.378-004 | 2.376-004 | 0.06 | 1.074-004 |
| 84.360 | 0.000 | 2.760-004 | 2.759-004 | 0.02 | 1.457-004 |
| 98.003 | 0.000 | 3.462-004 | 3.460-004 | 0.04 | 2.158-004 |
| 144.158 | 0.000 | 6.381-004 | 6.378-004 | 0.05 | 5.078-004 |
| 191.793 | 0.000 | 9.825-004 | 9.817-004 | 0.09 | 8.522-004 |
| 193.141 | 0.000 | 9.890-004 | 9.918-004 | -0.28 | 8.587-004 |
| 233.413 | 0.000 | 1.303-003 | 1.303-003 | 0.02 | 1.173-003 |

Table 19 Thermovoltage deviations for Armco iron, specimen 4.

| UPPER TEMPERATURE | LOWER TEMPERATURE | OBSERVED THERMOVOLTAGE | CALCULATED THERMOVOLTAGE | DEVIATION |
|----------------------|----------------------|---------------------------|-----------------------------|-----------|
| 6.766 | 5.313 | -0.03 | -0.12 | 0.09 |
| 10.118 | 6.940 | 0.06 | 0.28 | -0.22 |
| 15.258 | 10.137 | 0.31 | 0.24 | 0.07 |
| 6.800 | 5.330 | -0.02 | -0.12 | 0.10 |
| 26.560 | 16.710 | 2.68 | 2.71 | -0.03 |
| 26.606 | 16.721 | 2.72 | 2.73 | -0.01 |
| 19.775 | 13.557 | 0.73 | 0.58 | 0.15 |
| 23.551 | 21.713 | 0.49 | 0.57 | -0.08 |
| 26.964 | 23.496 | 1.41 | 1.54 | -0.13 |
| 36.655 | 27.491 | 8.60 | 8.72 | -0.12 |
| 61.507 | 37.794 | 77.53 | 77.36 | 0.17 |
| 94.938 | 57.922 | 282.46 | 282.65 | -0.19 |
| 84.986 | 78.525 | 55.32 | 55.19 | 0.13 |
| 106.759 | 85.882 | 218.50 | 218.42 | 0.08 |
| 157.630 | 101.934 | 734.22 | 734.13 | 0.09 |
| 266.661 | 152.379 | 1636.76 | 1636.91 | -0.15 |
| 320.650 | 200.283 | 1597.60 | 1597.72 | -0.12 |
| 240.238 | 203.059 | 534.88 | 534.46 | 0.42 |
| 331.843 | 239.825 | 1149.44 | 1149.36 | 0.08 |
| 280.736 | 222.654 | 794.32 | 794.22 | 0.10 |

Table 20 Transport properties of Armco iron, specimen 2.

| Temp (K) | Thermal Conductivity (Wm ⁻¹ K ⁻¹) | Electrical Resistivity (μohm m) | Lorenz ratio x 10 ⁸ (V ² /K ²) | Thermo- power (μV/K) |
|-------------|--|---------------------------------------|--|----------------------------|
| 6 | 21.7 | 0.006905 | 2.49 | 0.02 |
| 7 | 25.6 | 0.006903 | 2.52 | 0.06 |
| 8 | 29.2 | 0.006911 | 2.53 | 0.07 |
| 9 | 32.8 | 0.006920 | 2.53 | 0.06 |
| 10 | 36.4 | 0.006926 | 2.52 | 0.07 |
| 12 | 43.5 | 0.006929 | 2.51 | 0.13 |
| 14 | 50.7 | 0.006932 | 2.51 | 0.22 |
| 16 | 57.9 | 0.006941 | 2.51 | 0.32 |
| 18 | 65.0 | 0.006957 | 2.51 | 0.43 |
| 20 | 71.8 | 0.006981 | 2.50 | 0.54 |
| 25 | 87.0 | 0.007067 | 2.46 | 0.82 |
| 30 | 98.9 | 0.007196 | 2.37 | 1.18 |
| 35 | 107 | 0.007386 | 2.26 | 1.67 |
| 40 | 113 | 0.007664 | 2.16 | 2.28 |
| 45 | 115 | 0.008051 | 2.06 | 3.00 |
| 50 | 116 | 0.008562 | 1.99 | 3.79 |
| 55 | 115 | 0.009202 | 1.93 | 4.63 |
| 60 | 114 | 0.009976 | 1.89 | 5.51 |
| 65 | 112 | 0.01088 | 1.87 | 6.38 |
| 70 | 110 | 0.01191 | 1.87 | 7.24 |
| 75 | 107 | 0.01306 | 1.87 | 8.07 |
| 80 | 105 | 0.01432 | 1.88 | 8.86 |
| 85 | 103 | 0.01568 | 1.89 | 9.60 |
| 90 | 100 | 0.01713 | 1.91 | 10.30 |
| 95 | 98.4 | 0.01867 | 1.93 | 10.95 |
| 100 | 96.6 | 0.02028 | 1.96 | 11.54 |
| 110 | 93.4 | 0.02371 | 2.01 | 12.58 |
| 120 | 90.8 | 0.02736 | 2.07 | 13.44 |
| 130 | 88.7 | 0.03119 | 2.13 | 14.13 |
| 140 | 87.1 | 0.03516 | 2.19 | 14.67 |
| 150 | 85.8 | 0.03923 | 2.24 | 15.07 |
| 160 | 84.7 | 0.04340 | 2.30 | 15.37 |
| 170 | 83.9 | 0.04765 | 2.35 | 15.57 |
| 180 | 83.1 | 0.05196 | 2.40 | 15.69 |
| 190 | 82.4 | 0.05633 | 2.44 | 15.74 |
| 200 | 81.8 | 0.06077 | 2.48 | 15.73 |
| 220 | 80.5 | 0.06983 | 2.55 | 15.56 |
| 240 | 79.1 | 0.07918 | 2.61 | 15.23 |
| 260 | 77.5 | 0.08888 | 2.65 | 14.77 |
| 280 | 75.9 | 0.09903 | 2.68 | 14.19 |
| 300 | 74.3 | 0.10970 | 2.72 | 13.51 |

Table 21 Transport properties of Armco iron, specimen 2a.

| Temp (K) | Thermal Conductivity (Wm ⁻¹ K ⁻¹) | Electrical Resistivity (μ ohm m) | Lorenz ratio x 10 ⁸ (V ² /K ²) | Thermo- power (μV/K) |
|-------------|--|--|--|----------------------------|
| 6 | 19.7 | 0.007645 | 2.52 | -0.02 |
| 7 | 23.2 | 0.007645 | 2.53 | 0.08 |
| 8 | 26.6 | 0.007658 | 2.54 | 0.11 |
| 9 | 29.9 | 0.007669 | 2.55 | 0.11 |
| 10 | 33.2 | 0.007674 | 2.55 | 0.11 |
| 12 | 39.8 | 0.007676 | 2.54 | 0.15 |
| 14 | 46.4 | 0.007676 | 2.54 | 0.23 |
| 16 | 52.9 | 0.007685 | 2.54 | 0.33 |
| 18 | 59.4 | 0.007702 | 2.54 | 0.44 |
| 20 | 65.6 | 0.007726 | 2.53 | 0.56 |
| 25 | 79.8 | 0.007812 | 2.49 | 0.87 |
| 30 | 91.2 | 0.007936 | 2.41 | 1.25 |
| 35 | 99.6 | 0.008119 | 2.31 | 1.75 |
| 40 | 105 | 0.008388 | 2.21 | 2.37 |
| 45 | 108 | 0.008766 | 2.11 | 3.09 |
| 50 | 110 | 0.009268 | 2.04 | 3.87 |
| 55 | 110 | 0.009902 | 1.98 | 4.72 |
| 60 | 109 | 0.01067 | 1.94 | 5.58 |
| 65 | 108 | 0.01157 | 1.92 | 6.45 |
| 70 | 106 | 0.01259 | 1.91 | 7.30 |
| 75 | 104 | 0.01374 | 1.91 | 8.12 |
| 80 | 102 | 0.01500 | 1.91 | 8.91 |
| 85 | 100 | 0.01635 | 1.93 | 9.65 |
| 90 | 98.4 | 0.01781 | 1.95 | 10.34 |
| 95 | 96.7 | 0.01934 | 1.97 | 10.97 |
| 100 | 95.1 | 0.02096 | 1.99 | 11.56 |
| 110 | 92.3 | 0.02438 | 2.05 | 12.59 |
| 120 | 90.1 | 0.02803 | 2.10 | 13.43 |
| 130 | 88.3 | 0.03185 | 2.16 | 14.10 |
| 140 | 86.9 | 0.03581 | 2.22 | 14.63 |
| 150 | 85.7 | 0.03988 | 2.28 | 15.02 |
| 160 | 84.7 | 0.04404 | 2.33 | 15.31 |
| 170 | 83.8 | 0.04827 | 2.38 | 15.50 |
| 180 | 83.0 | 0.05258 | 2.42 | 15.62 |
| 190 | 82.2 | 0.05694 | 2.46 | 15.67 |
| 200 | 81.4 | 0.06137 | 2.50 | 15.66 |
| 220 | 79.8 | 0.07042 | 2.56 | 15.50 |
| 240 | 78.2 | 0.07978 | 2.60 | 15.18 |
| 260 | 76.6 | 0.08952 | 2.64 | 14.72 |
| 280 | 75.3 | 0.09971 | 2.68 | 14.14 |

Table 22 Transport properties of Armco iron, specimen 4.

| Temp (K) | Thermal Conductivity (Wm ⁻¹ K ⁻¹) | Electrical Resistivity (μohm m) | Lorenz ratio × 10 ⁸ (V ² /K ²) | Thermo- power (μV/K) |
|-------------|--|---------------------------------------|--|----------------------------|
| 6 | 19.6 | 0.007675 | 2.51 | -0.07 |
| 7 | 23.0 | 0.007664 | 2.52 | 0.07 |
| 8 | 26.3 | 0.007673 | 2.52 | 0.11 |
| 9 | 29.6 | 0.007685 | 2.53 | 0.11 |
| 10 | 32.9 | 0.007694 | 2.53 | 0.11 |
| 12 | 39.4 | 0.007702 | 2.53 | 0.13 |
| 14 | 46.0 | 0.007706 | 2.53 | 0.19 |
| 16 | 52.5 | 0.007715 | 2.53 | 0.28 |
| 18 | 58.9 | 0.007730 | 2.53 | 0.39 |
| 20 | 65.1 | 0.007752 | 2.52 | 0.50 |
| 25 | 79.1 | 0.007834 | 2.48 | 0.80 |
| 30 | 90.5 | 0.007960 | 2.40 | 1.18 |
| 35 | 98.9 | 0.008149 | 2.30 | 1.66 |
| 40 | 105 | 0.008427 | 2.20 | 2.27 |
| 45 | 108 | 0.008814 | 2.11 | 2.97 |
| 50 | 109 | 0.009324 | 2.04 | 3.74 |
| 55 | 110 | 0.009965 | 1.98 | 4.58 |
| 60 | 109 | 0.01074 | 1.95 | 5.44 |
| 65 | 107 | 0.01164 | 1.92 | 6.30 |
| 70 | 106 | 0.01267 | 1.91 | 7.15 |
| 75 | 104 | 0.01382 | 1.91 | 7.98 |
| 80 | 102 | 0.01507 | 1.92 | 8.77 |
| 85 | 99.8 | 0.01643 | 1.93 | 9.51 |
| 90 | 97.9 | 0.01789 | 1.95 | 10.20 |
| 95 | 96.2 | 0.01942 | 1.97 | 10.85 |
| 100 | 94.6 | 0.02104 | 1.99 | 11.44 |
| 110 | 91.8 | 0.02446 | 2.04 | 12.47 |
| 120 | 89.6 | 0.02811 | 2.10 | 13.31 |
| 130 | 87.9 | 0.03193 | 2.16 | 13.99 |
| 140 | 86.5 | 0.03589 | 2.22 | 14.51 |
| 150 | 85.4 | 0.03996 | 2.28 | 14.91 |
| 160 | 84.5 | 0.04412 | 2.33 | 15.20 |
| 170 | 83.8 | 0.04836 | 2.38 | 15.39 |
| 180 | 83.1 | 0.05267 | 2.43 | 15.51 |
| 190 | 82.4 | 0.05704 | 2.47 | 15.56 |
| 200 | 81.8 | 0.06146 | 2.51 | 15.55 |
| 220 | 80.4 | 0.07052 | 2.58 | 15.39 |
| 240 | 78.8 | 0.07986 | 2.62 | 15.07 |
| 260 | 77.0 | 0.08957 | 2.65 | 14.62 |
| 280 | 75.3 | 0.09973 | 2.68 | 14.05 |
| 300 | 73.8 | 0.11040 | 2.71 | 13.36 |

Table 23 The Lorenz ratio and intrinsic electrical resistivity of Armco iron
(average of the results from specimens 2, 2a, and 4.)

| Temp (K) | Lorenz ratio $\times 10^8$ (V^2/K^2) | Intrinsic Electrical Resistivity (μ ohm m) |
|-------------|--|--|
| 4 | 2.263 | 0.0000 |
| 5 | 2.455 | 0.0000 |
| 6 | 2.505 | 0.0000 |
| 7 | 2.523 | 0.0000 |
| 8 | 2.531 | 0.0000 |
| 9 | 2.533 | 0.0000 |
| 10 | 2.532 | 0.0000 |
| 12 | 2.529 | 0.0000 |
| 14 | 2.528 | 0.0000 |
| 16 | 2.528 | 0.0000 |
| 18 | 2.527 | 0.0001 |
| 20 | 2.521 | 0.0001 |
| 25 | 2.477 | 0.0002 |
| 30 | 2.395 | 0.0003 |
| 35 | 2.292 | 0.0005 |
| 40 | 2.188 | 0.0008 |
| 45 | 2.096 | 0.0011 |
| 50 | 2.021 | 0.0016 |
| 55 | 1.965 | 0.0023 |
| 60 | 1.927 | 0.0030 |
| 65 | 1.905 | 0.0040 |
| 70 | 1.895 | 0.0050 |
| 75 | 1.895 | 0.0061 |
| 80 | 1.903 | 0.0074 |
| 85 | 1.917 | 0.0087 |
| 90 | 1.935 | 0.0102 |
| 95 | 1.956 | 0.0117 |
| 100 | 1.980 | 0.0134 |
| 110 | 2.034 | 0.0168 |
| 120 | 2.091 | 0.0204 |
| 130 | 2.150 | 0.0242 |
| 140 | 2.209 | 0.0282 |
| 150 | 2.266 | 0.0323 |
| 160 | 2.320 | 0.0364 |
| 170 | 2.371 | 0.0407 |
| 180 | 2.418 | 0.0450 |
| 190 | 2.461 | 0.0494 |
| 200 | 2.499 | 0.0538 |
| 220 | 2.562 | 0.0628 |
| 240 | 2.610 | 0.0722 |
| 260 | 2.647 | 0.0819 |
| 280 | 2.682 | 0.0921 |
| 300 | 2.724 | 0.1028 |

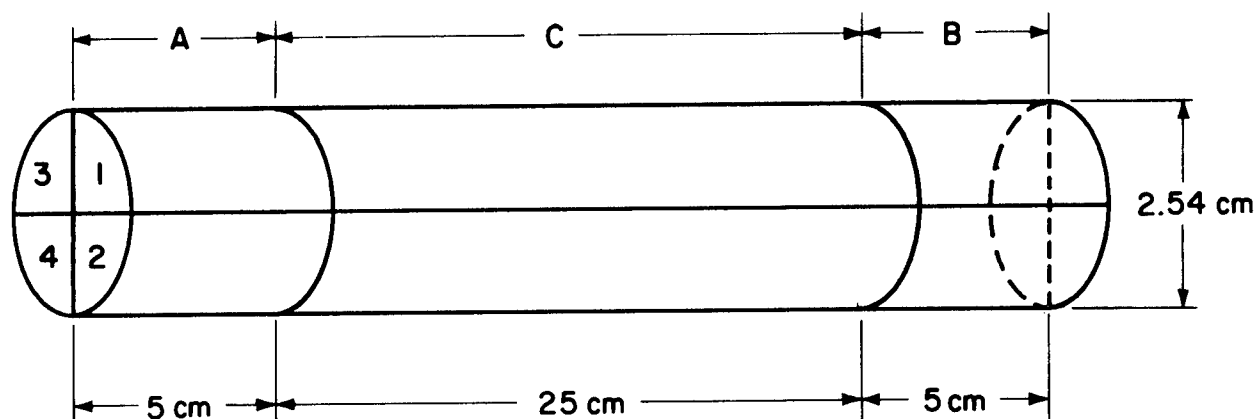


Figure 1. Division of Armco iron rod. Each of the 12 pieces shown was machined into a circular cylinder for measurement.

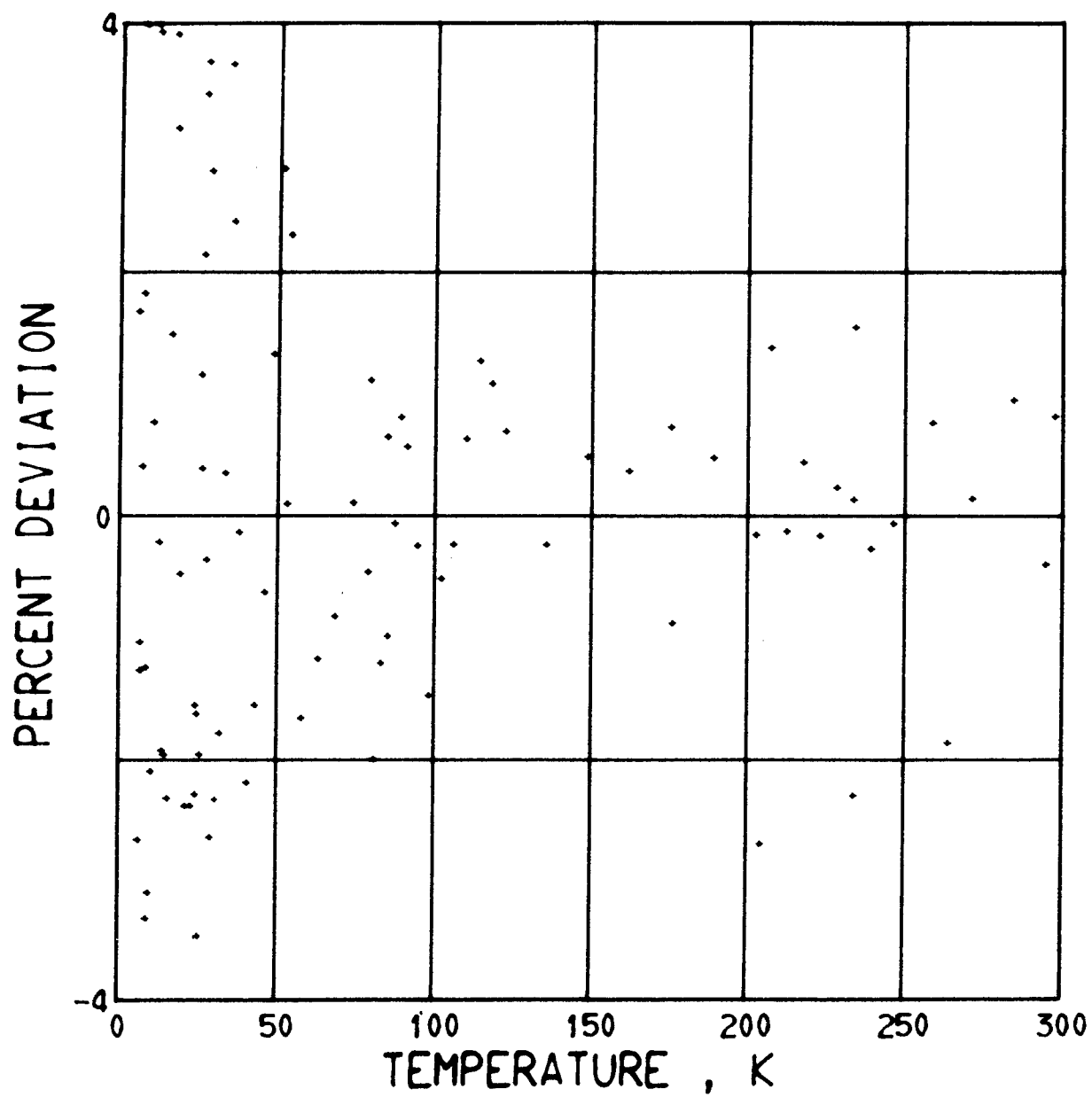


Figure 2. Thermal conductivity deviations for Armco iron, specimen 2.

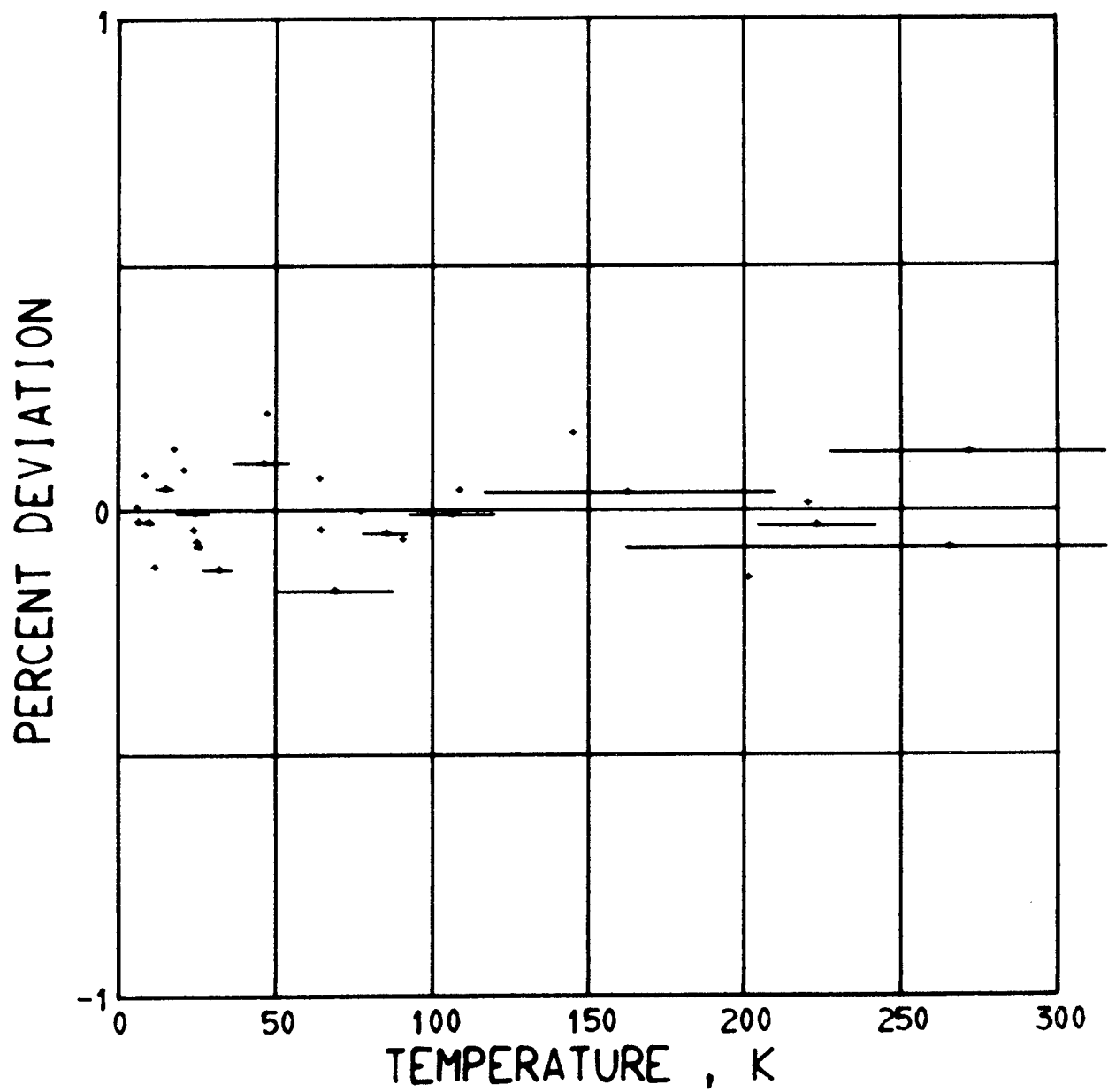


Figure 3. Electrical resistivity deviations for Armco iron, specimen 2.

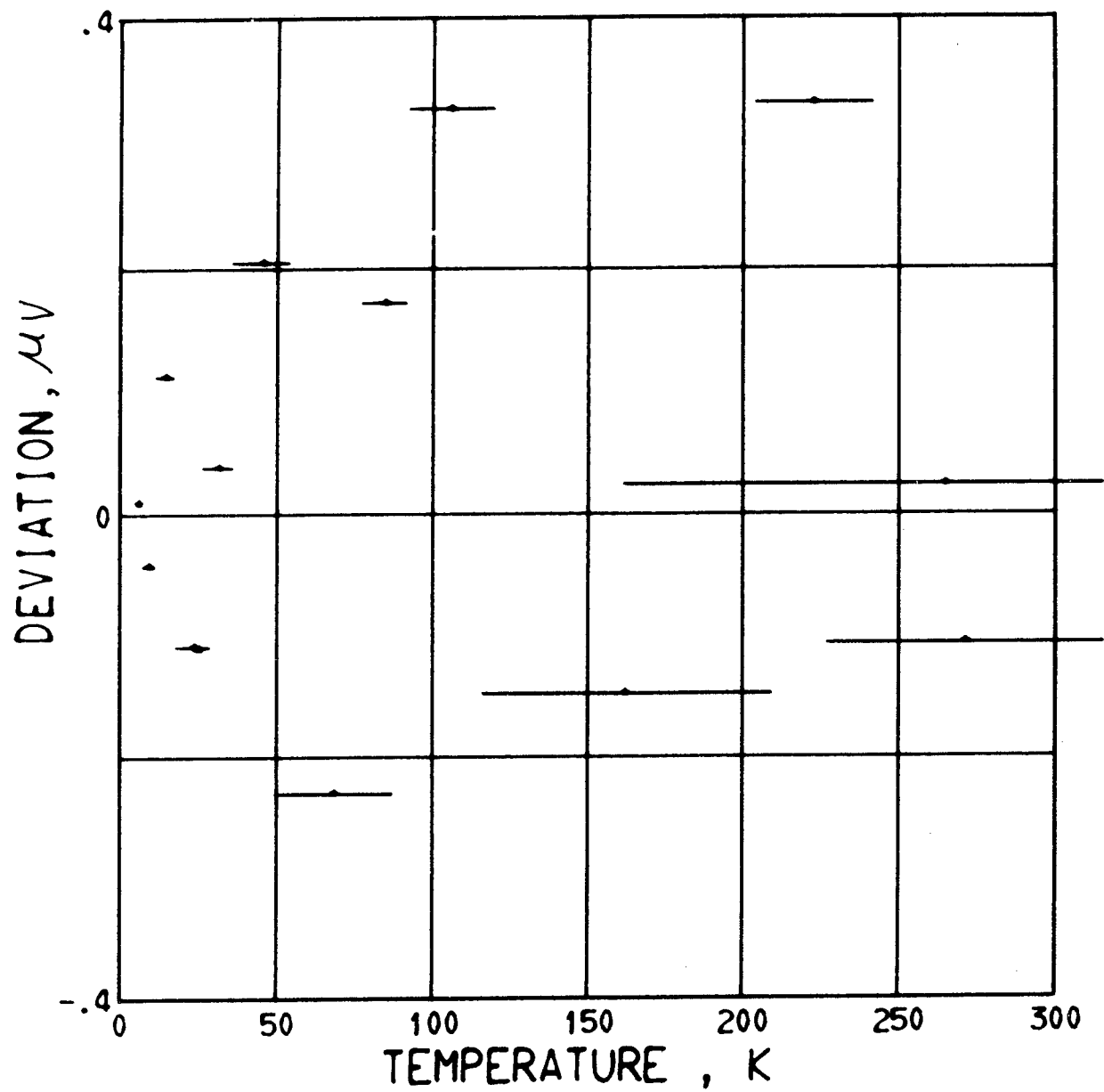


Figure 4. Thermovoltage deviations for Armco iron, specimen 2.

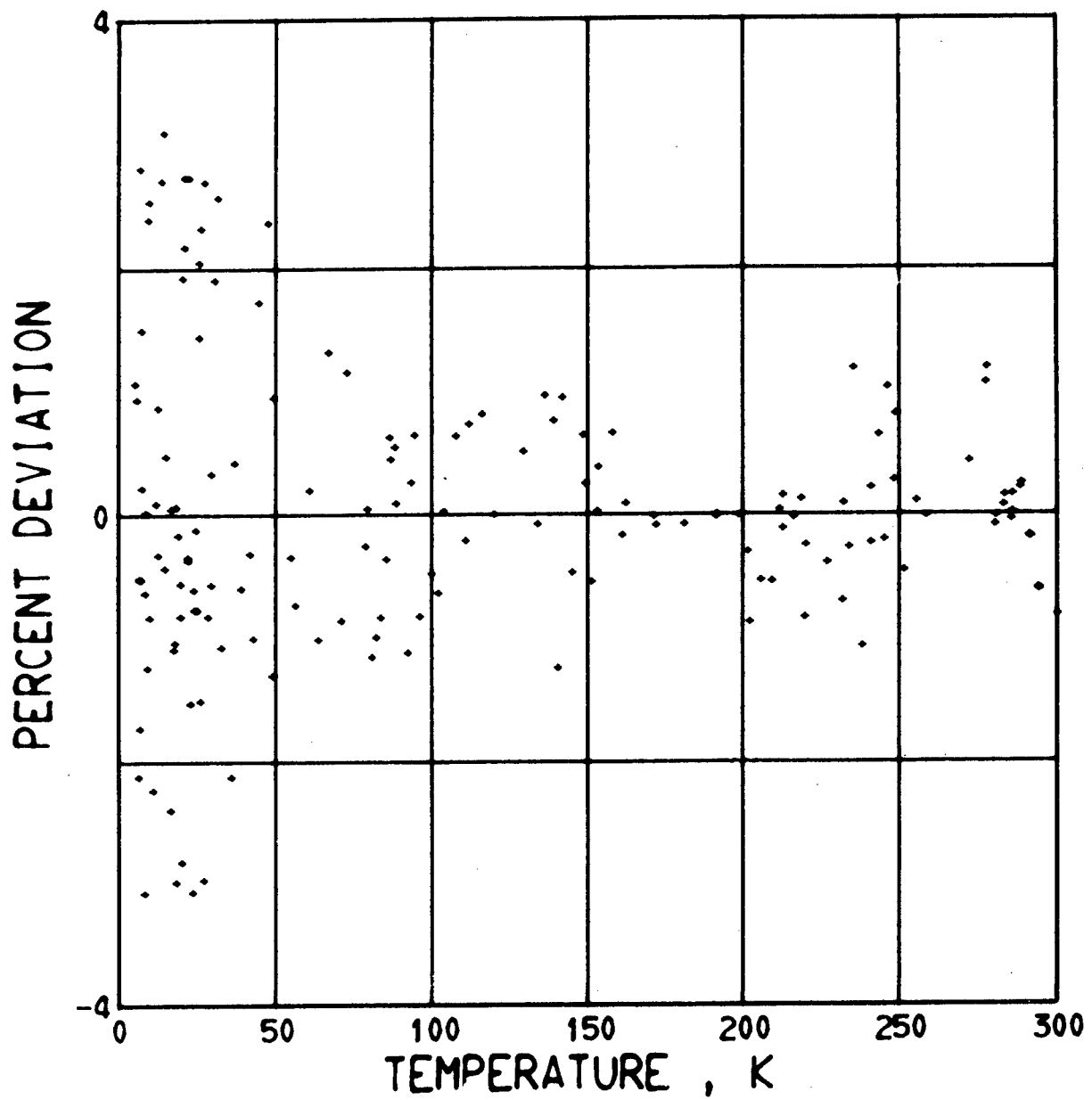


Figure 5. Thermal conductivity deviations for Armco iron, specimen 2a.

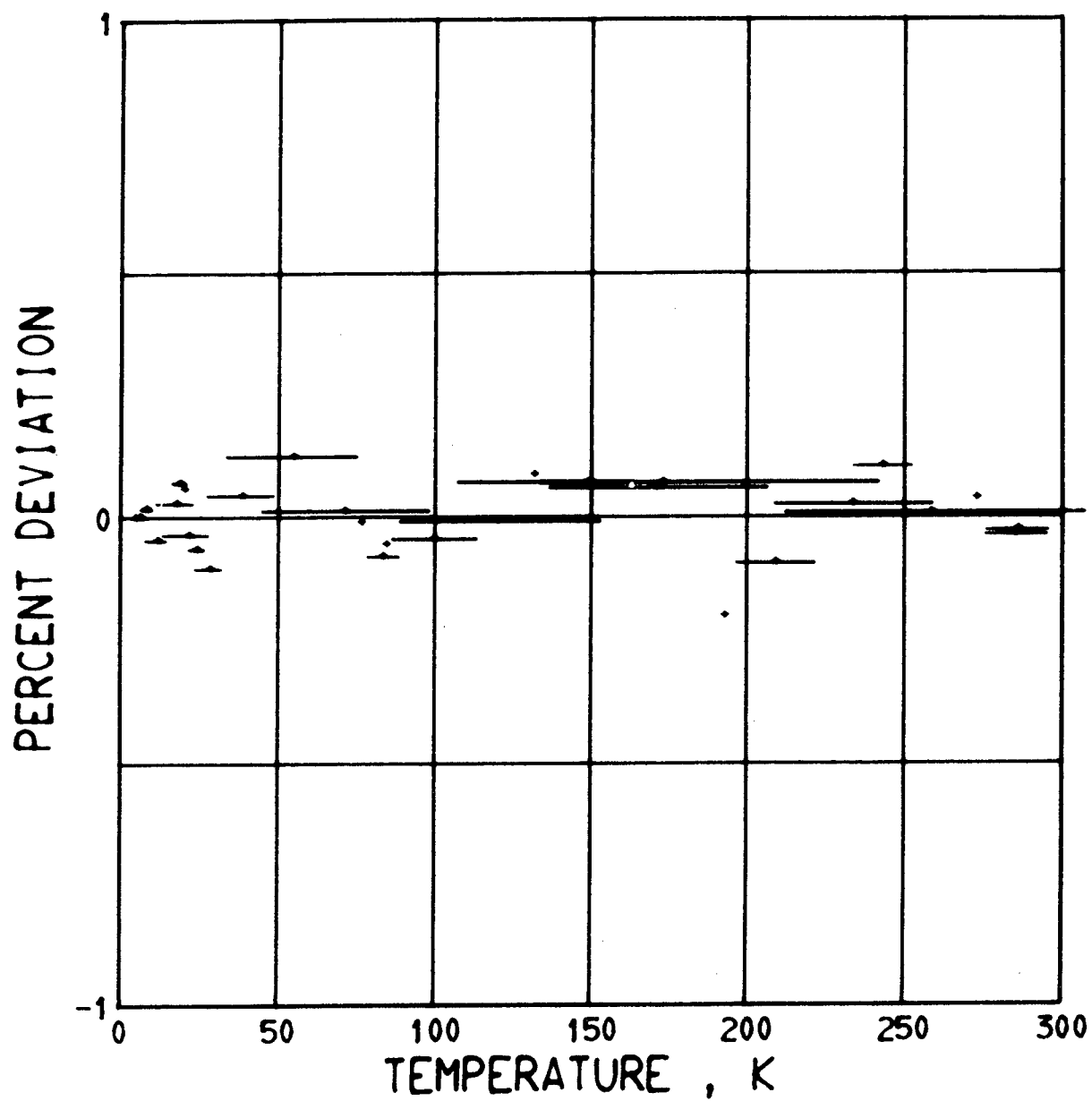


Figure 6. Electrical resistivity deviations for Armco iron, specimen 2a.

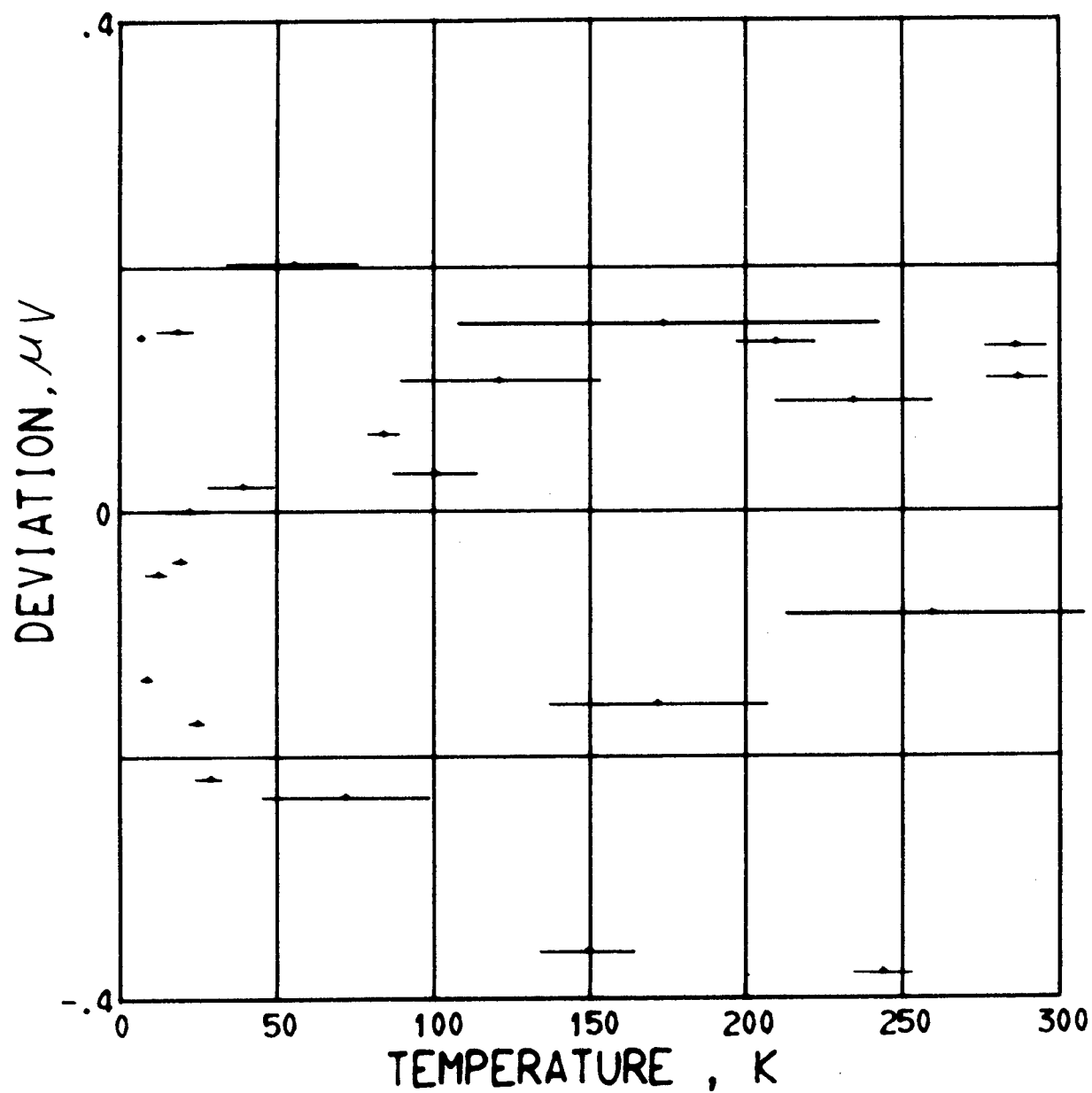


Figure 7. Thermovoltage deviations for Armco iron, specimen 2a.

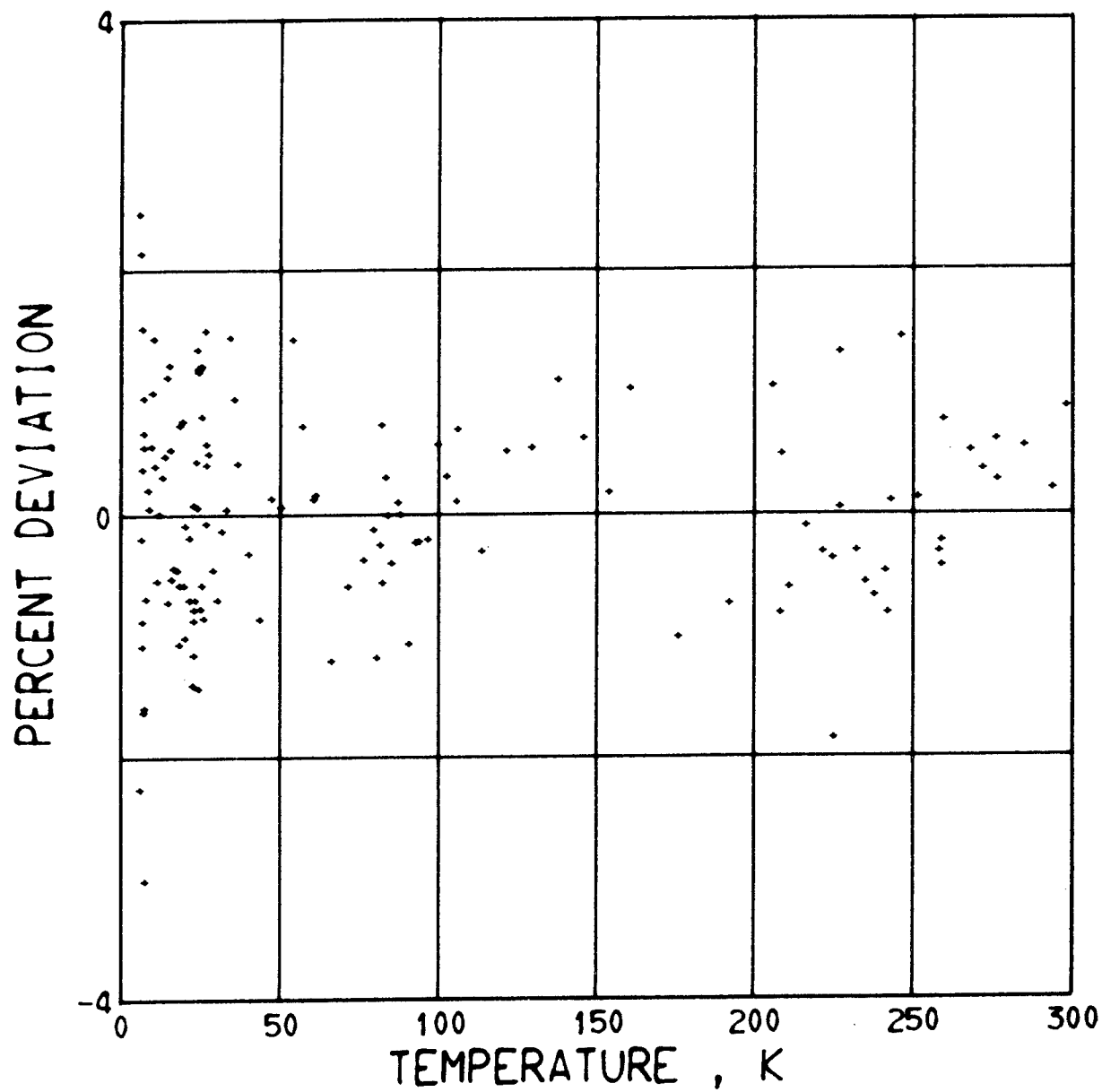


Figure 8. Thermal conductivity deviations for Armco iron, specimen 4.

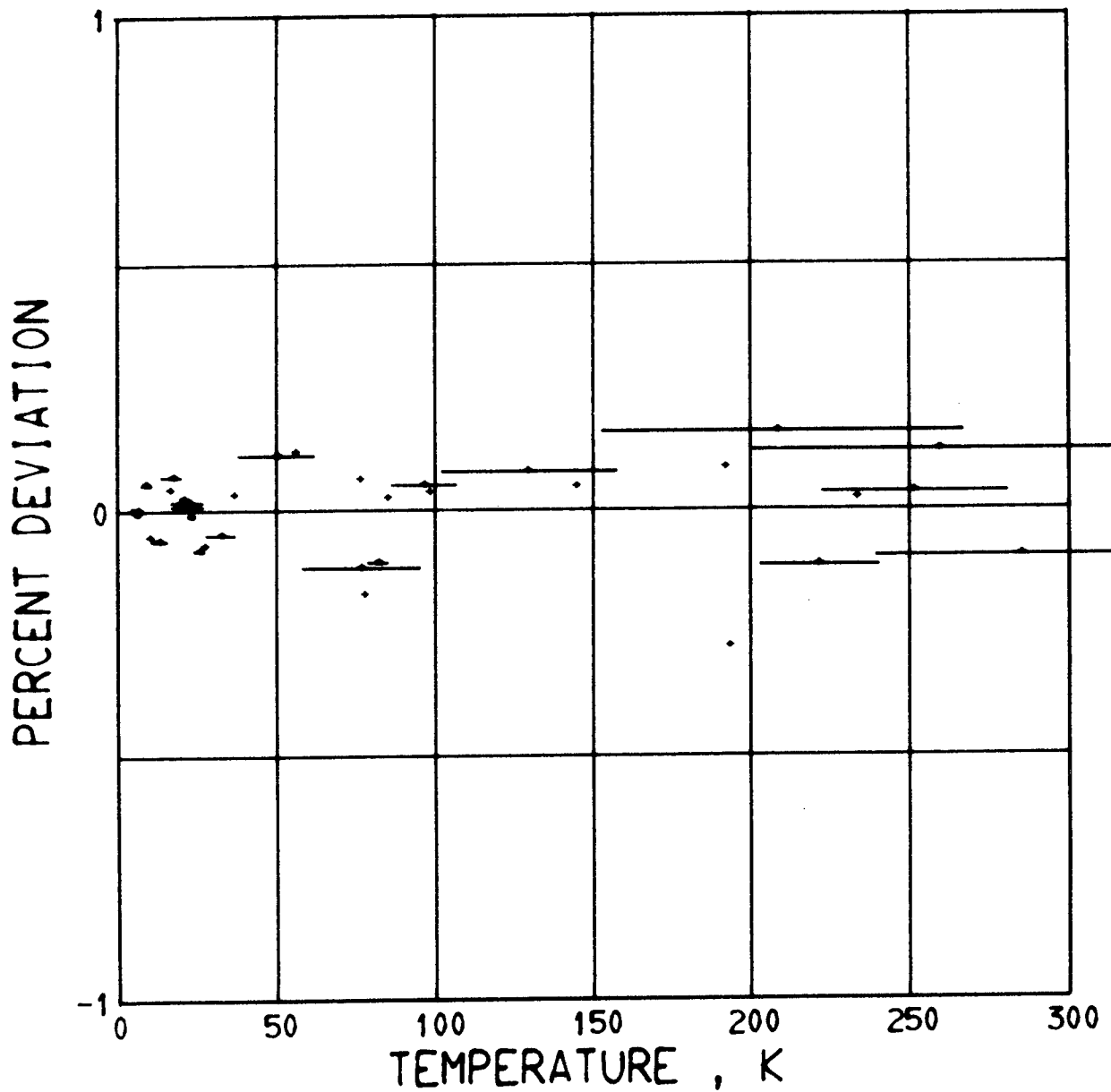


Figure 9. Electrical resistivity deviations for Armco iron, specimen 4.

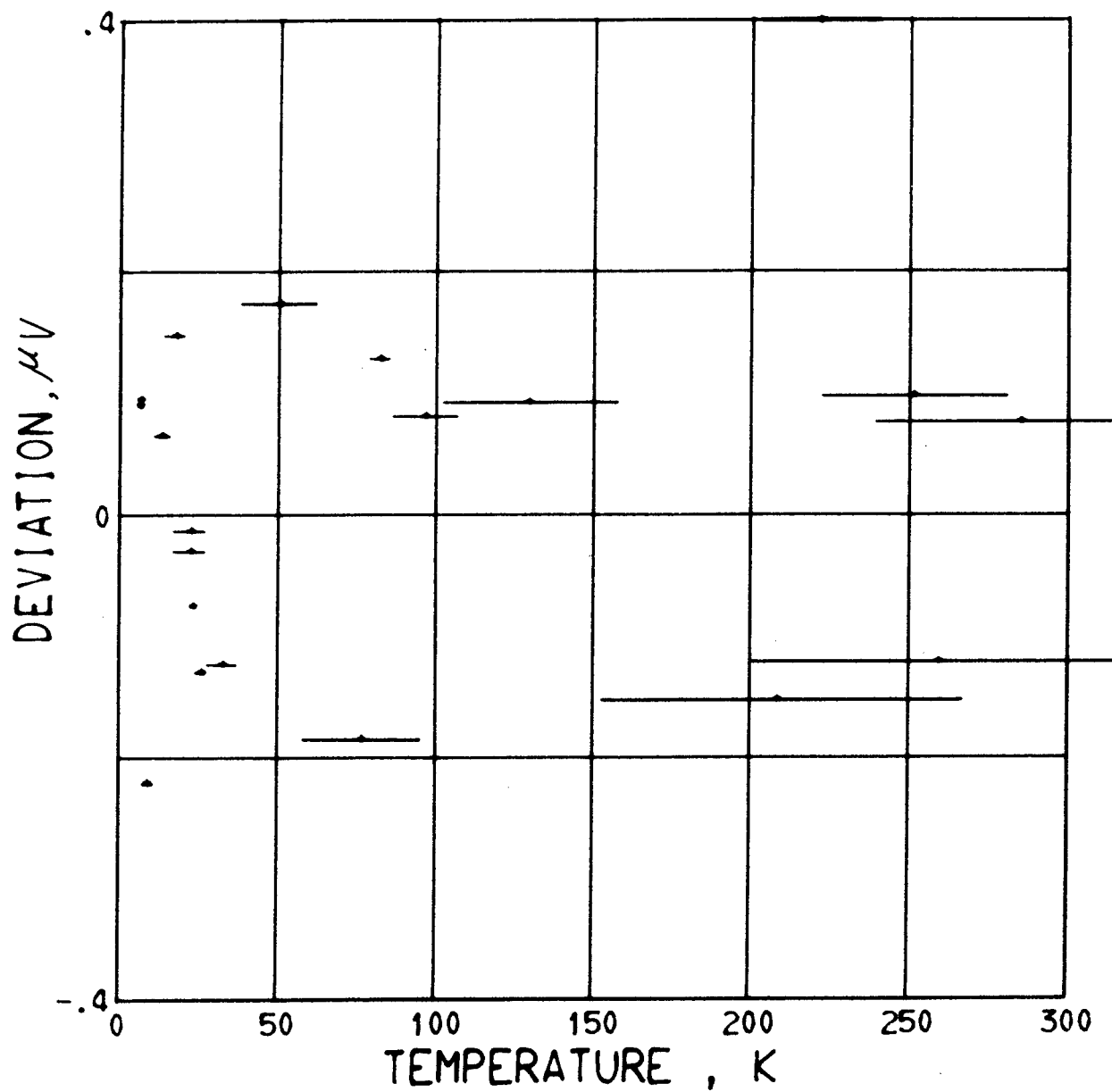


Figure 10. Thermovoltage deviations for Armco iron, specimen 4.

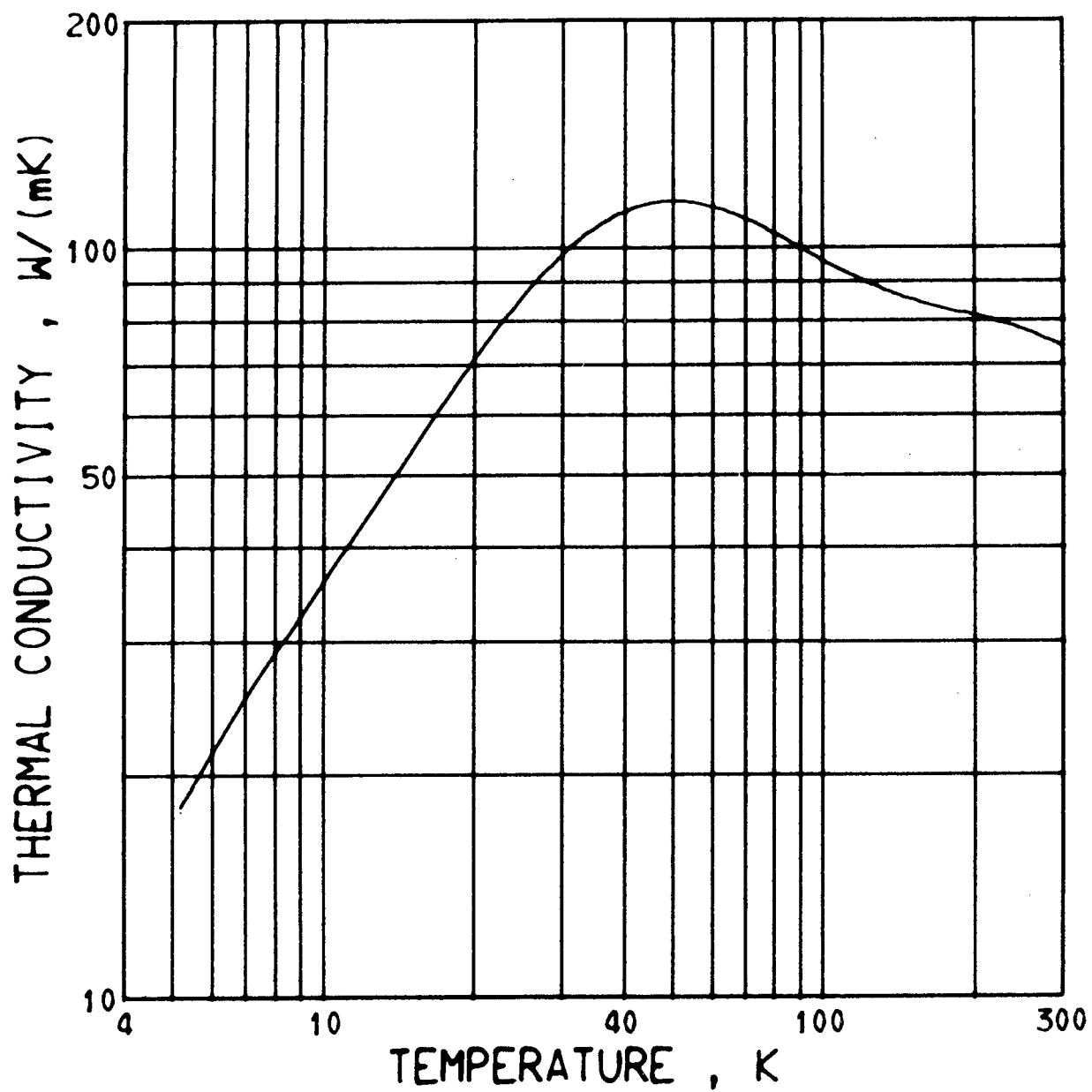


Figure 11a. Thermal conductivity of Armco iron, specimen 2.

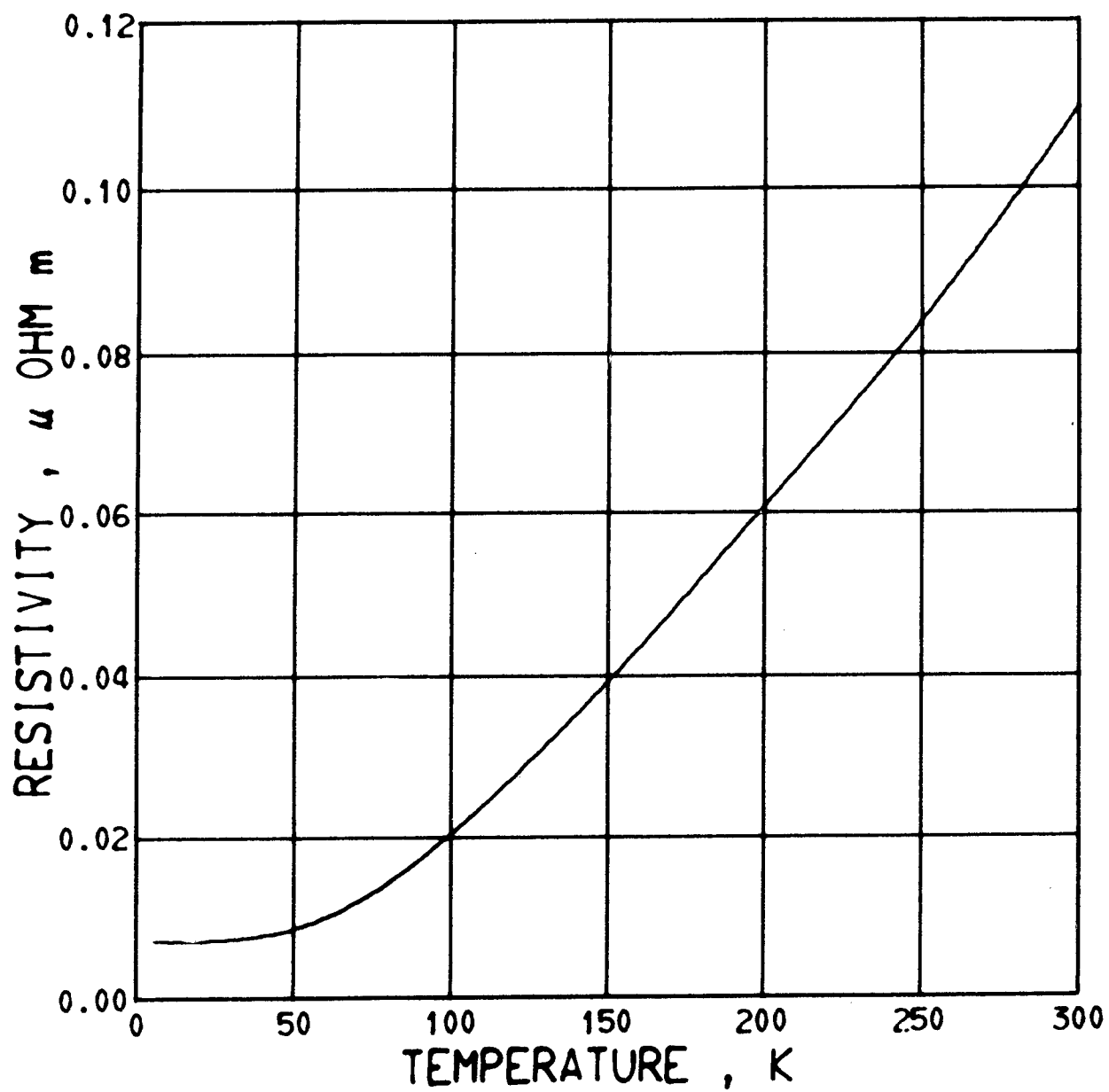


Figure 11b. Electrical resistivity of Armco iron, specimen 2.

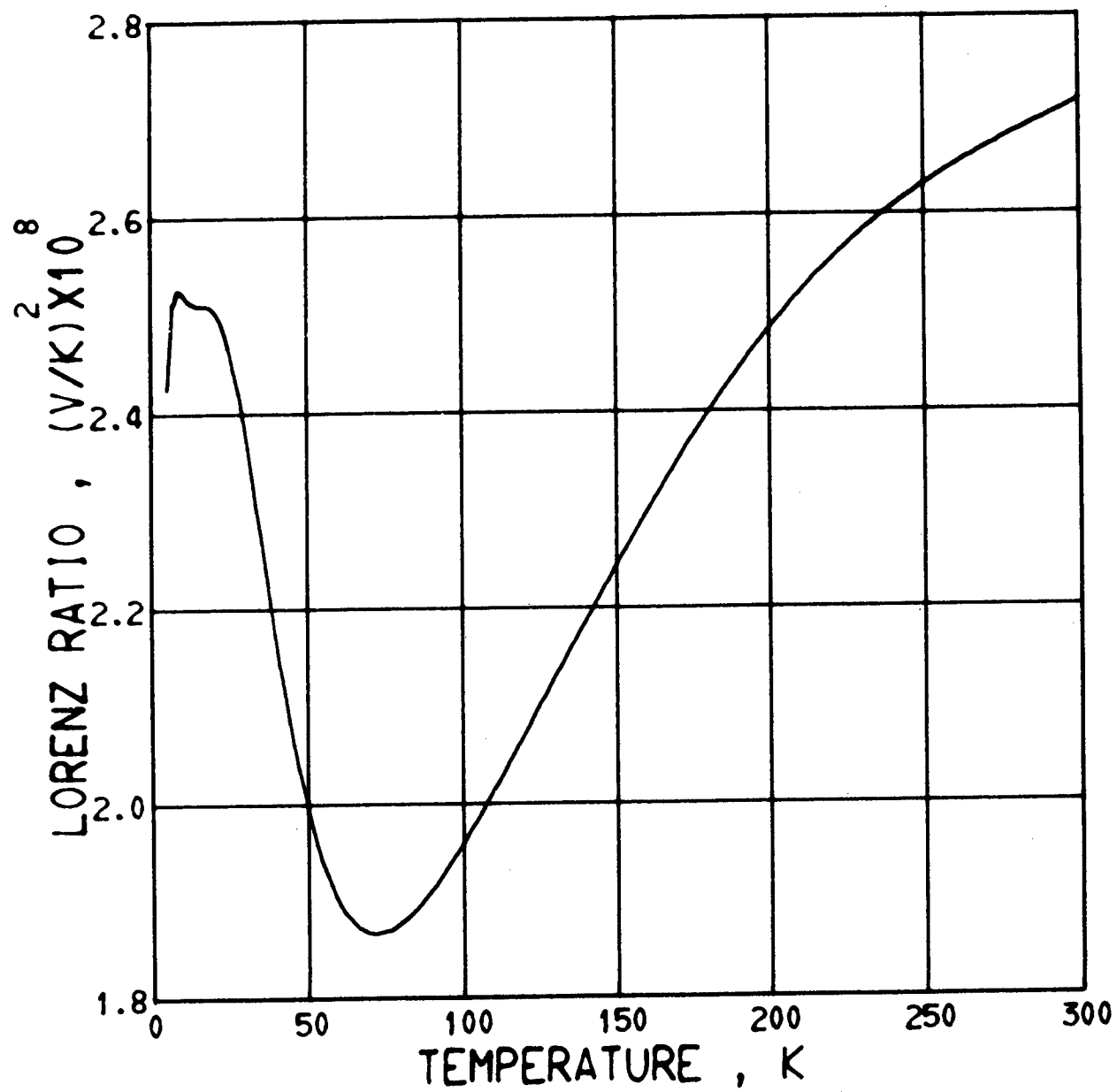


Figure 11c. Lorenz ratio of Armco iron, specimen 2.

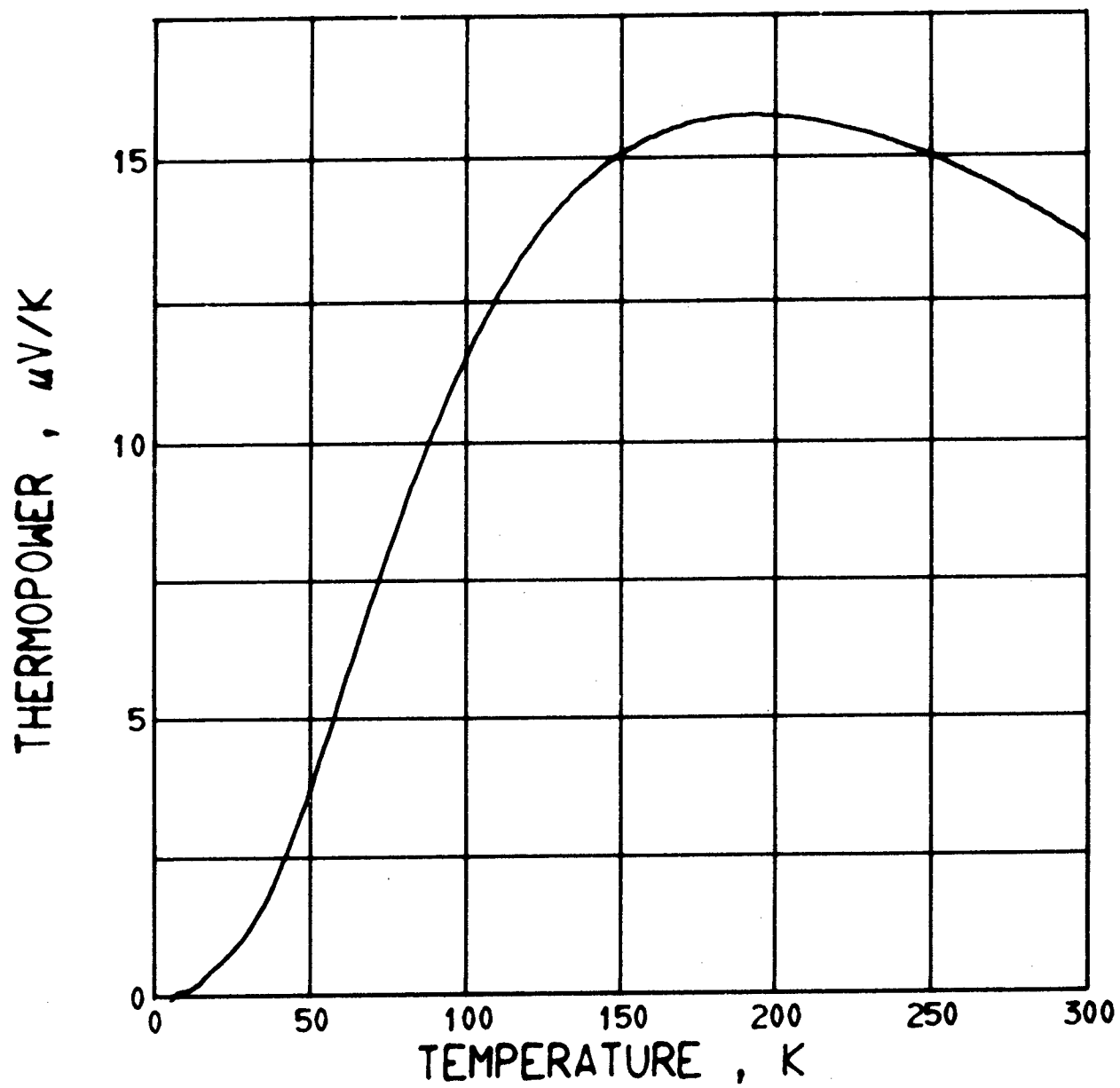


Figure 1ld. Thermopower of Armco iron, specimen 2.

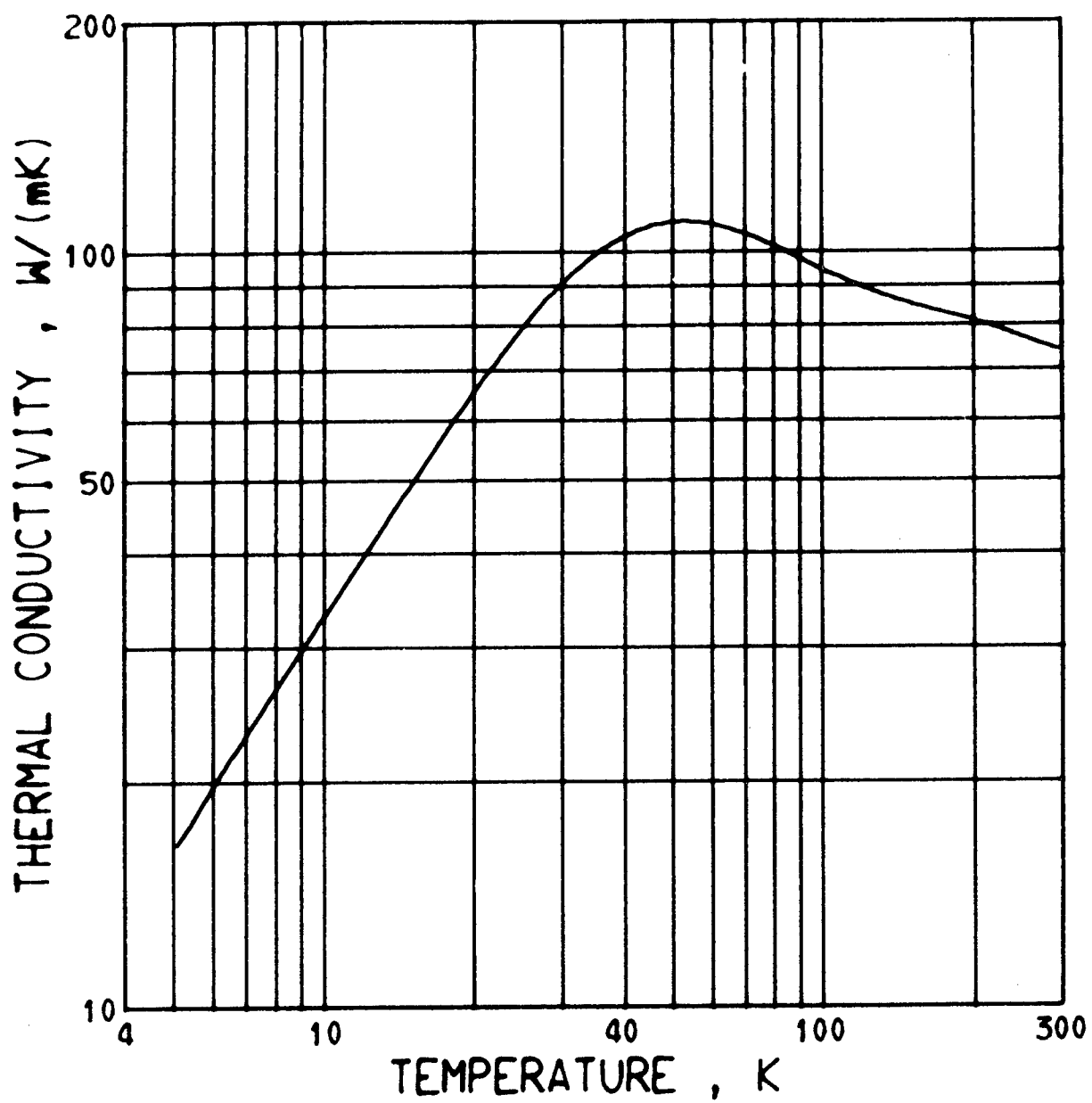


Figure 12a. Thermal conductivity of Armco iron, specimen 2a.

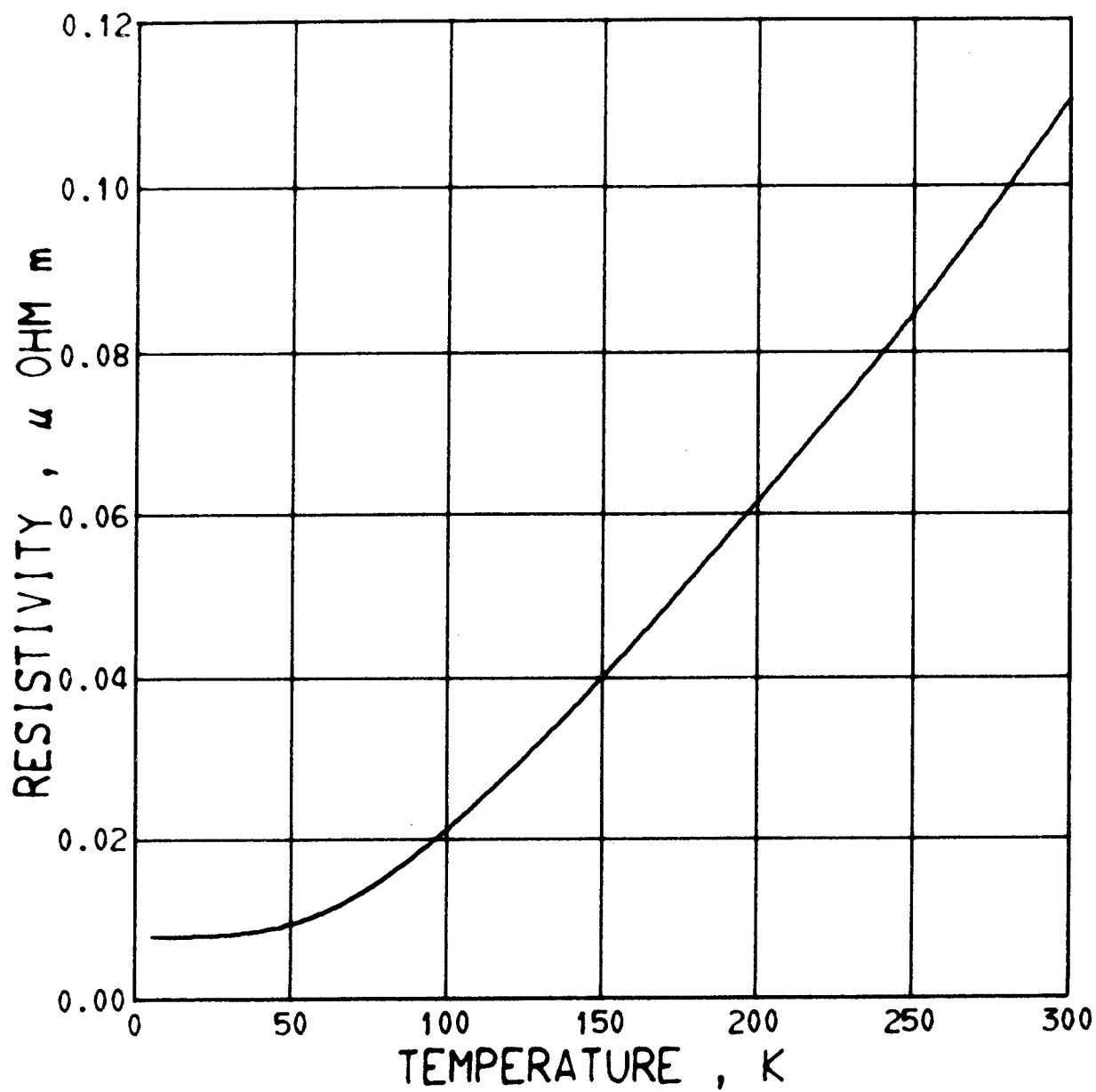


Figure 12b. Electrical resistivity of Armco iron, specimen 2a.

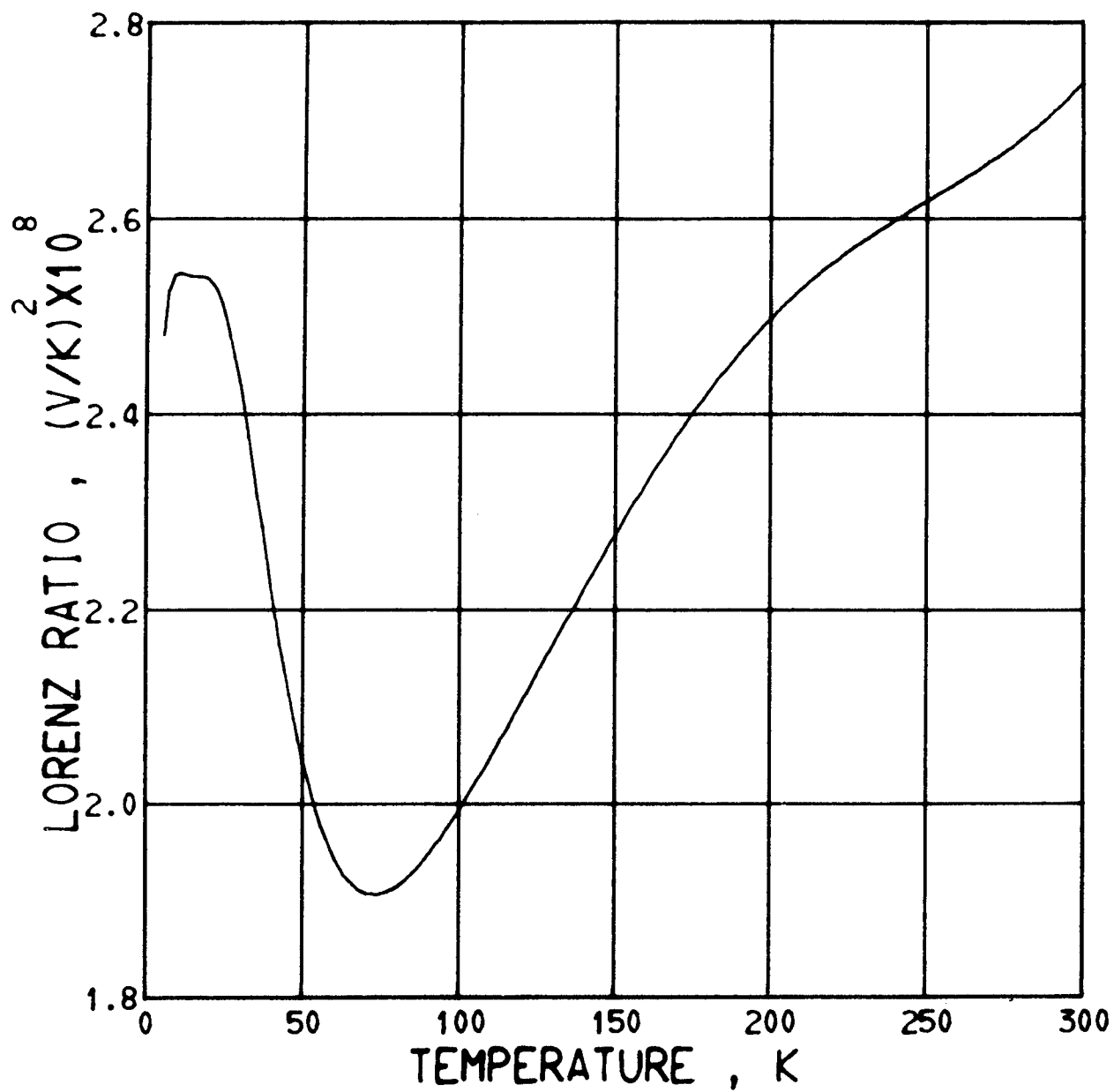


Figure 12c. Lorenz ratio of Armco iron, specimen 2a.

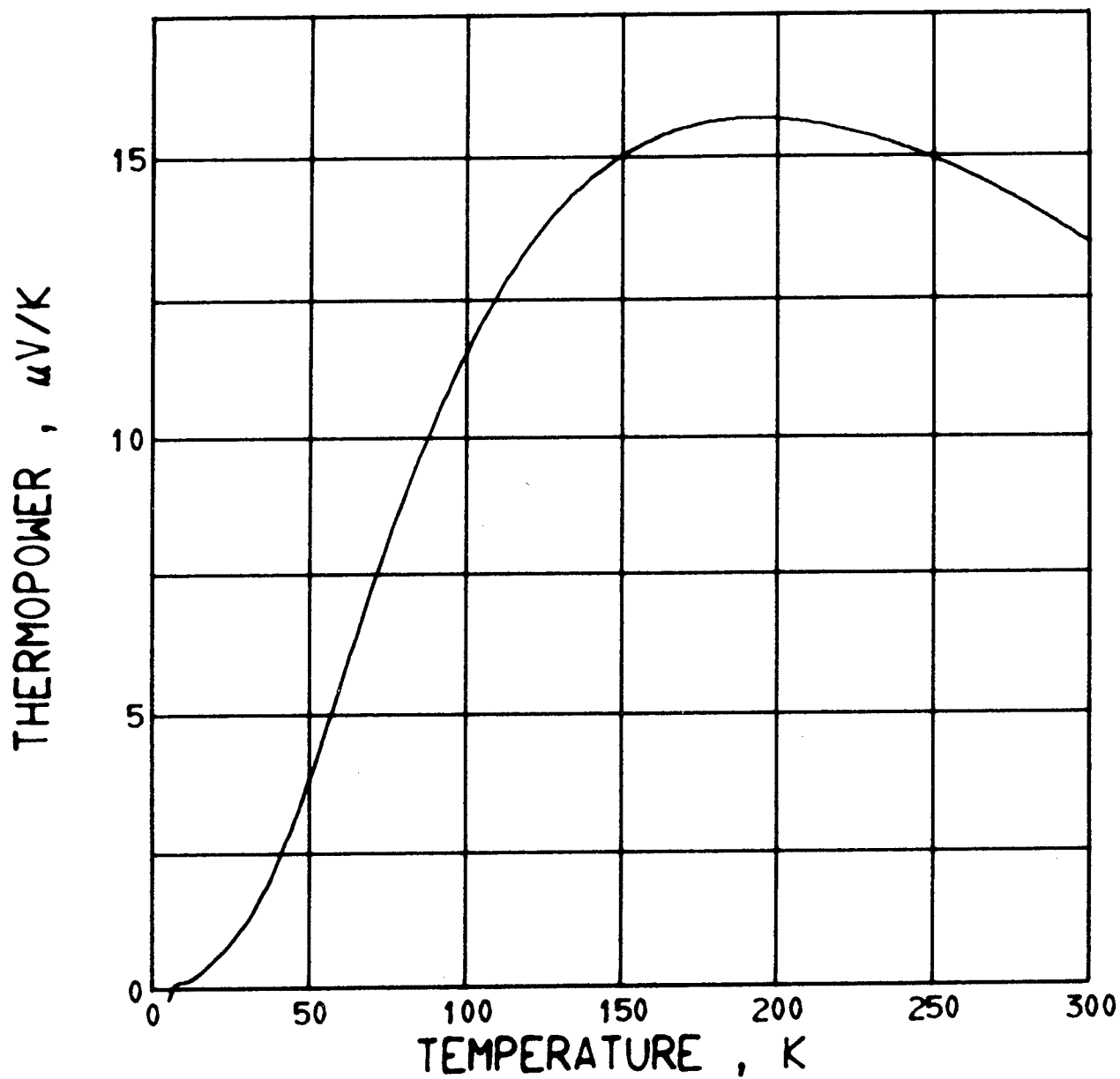


Figure 12d. Thermopower of Armco iron, specimen 2a.

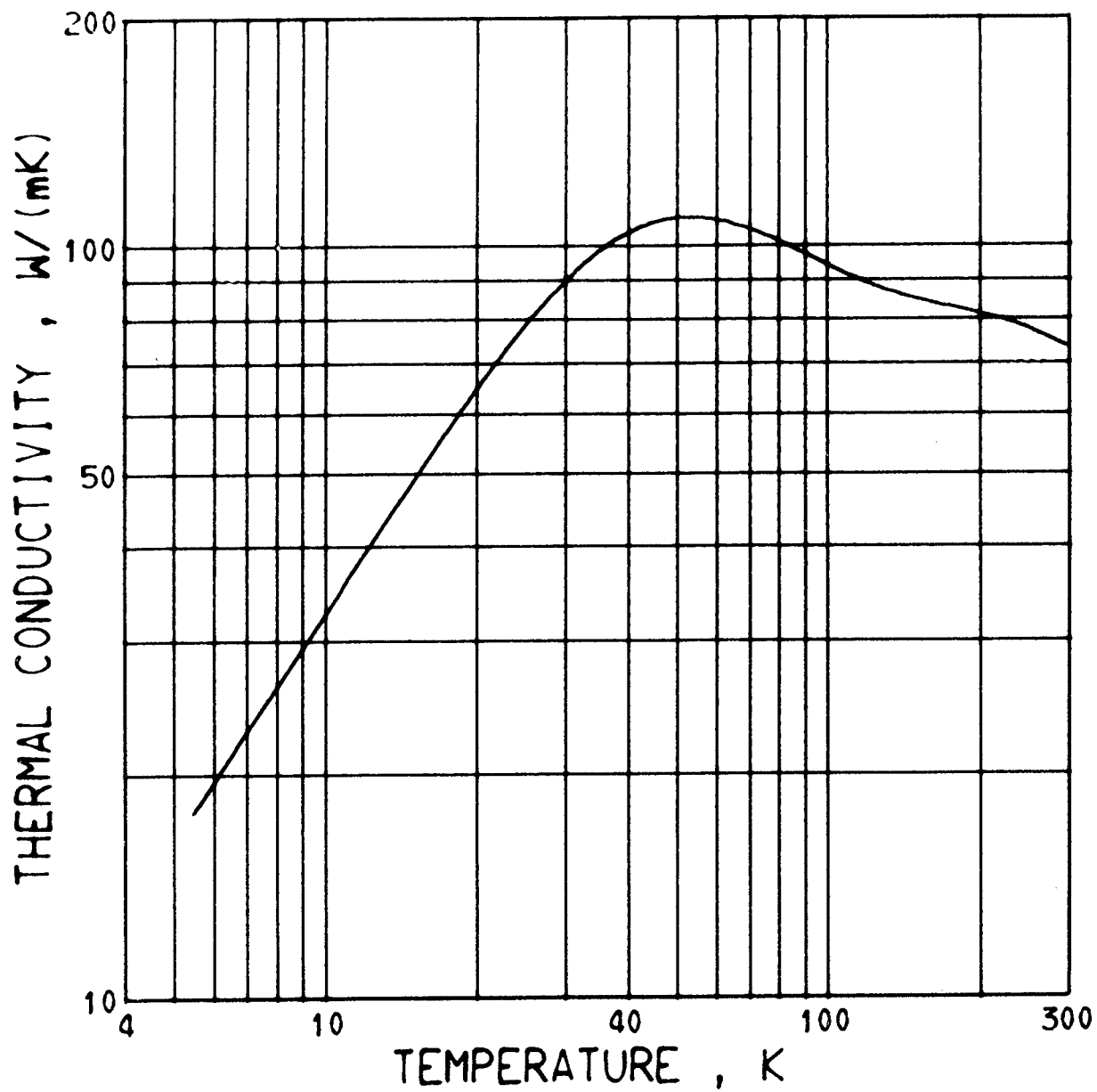


Figure 13a. Thermal conductivity of Armco iron, specimen 4.

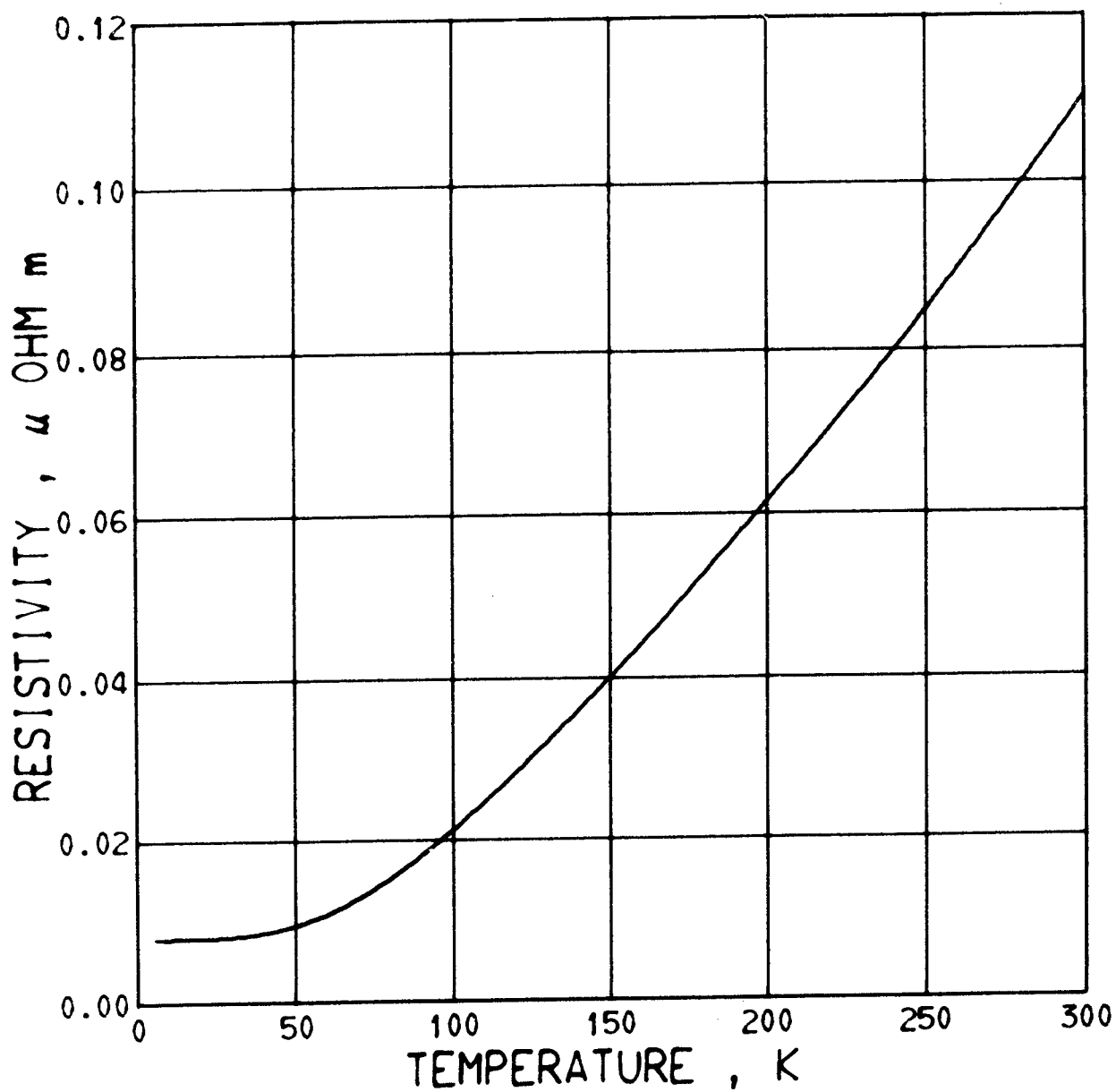


Figure 13b. Electrical resistivity of Armco iron, specimen 4.

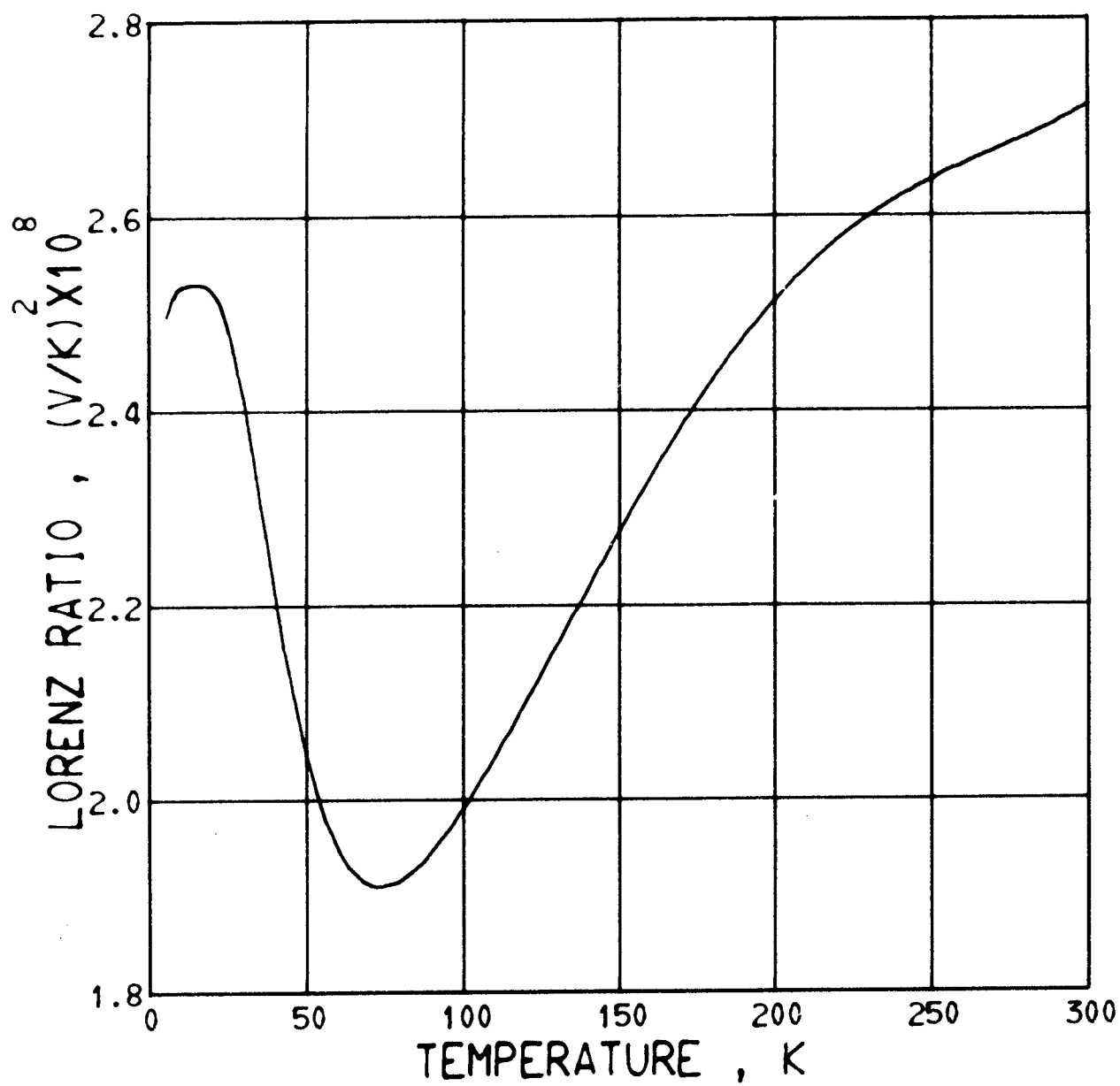


Figure 13c. Lorenz ratio of Armco iron, specimen 4.

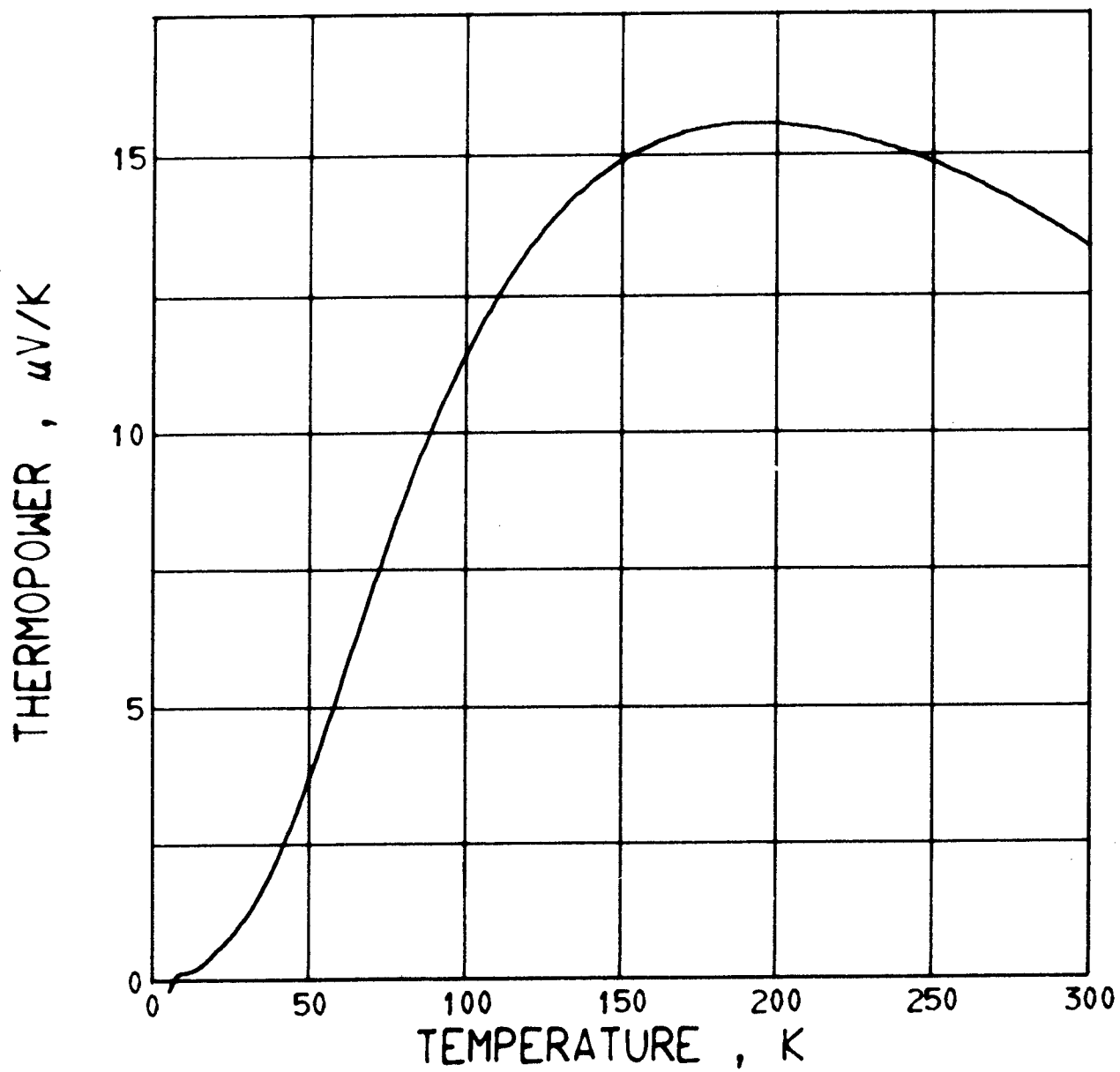


Figure 13d. Thermopower of Armco iron, specimen 4.

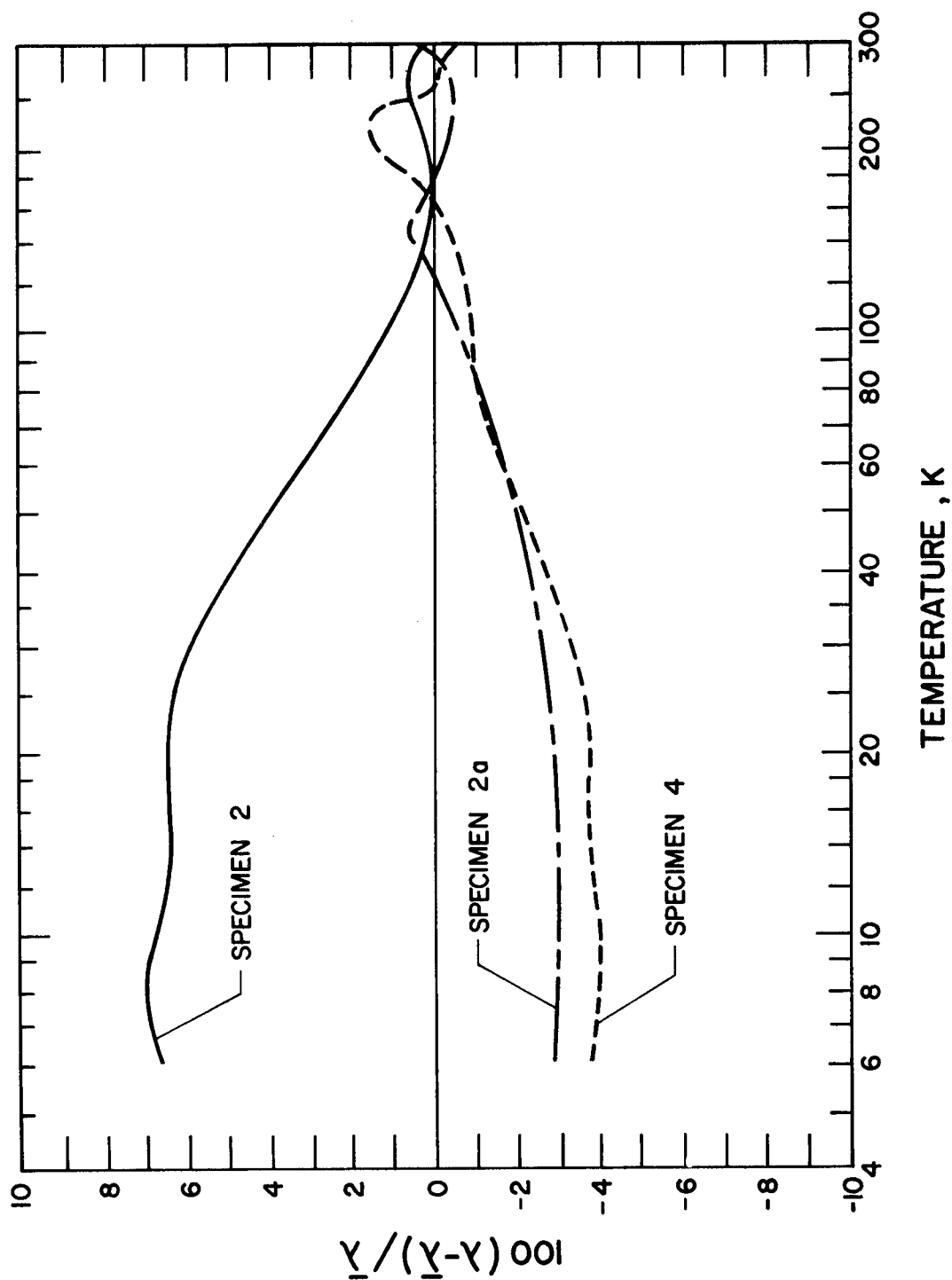


Figure 14. Deviations of the thermal conductivities of each specimen from the mean values.

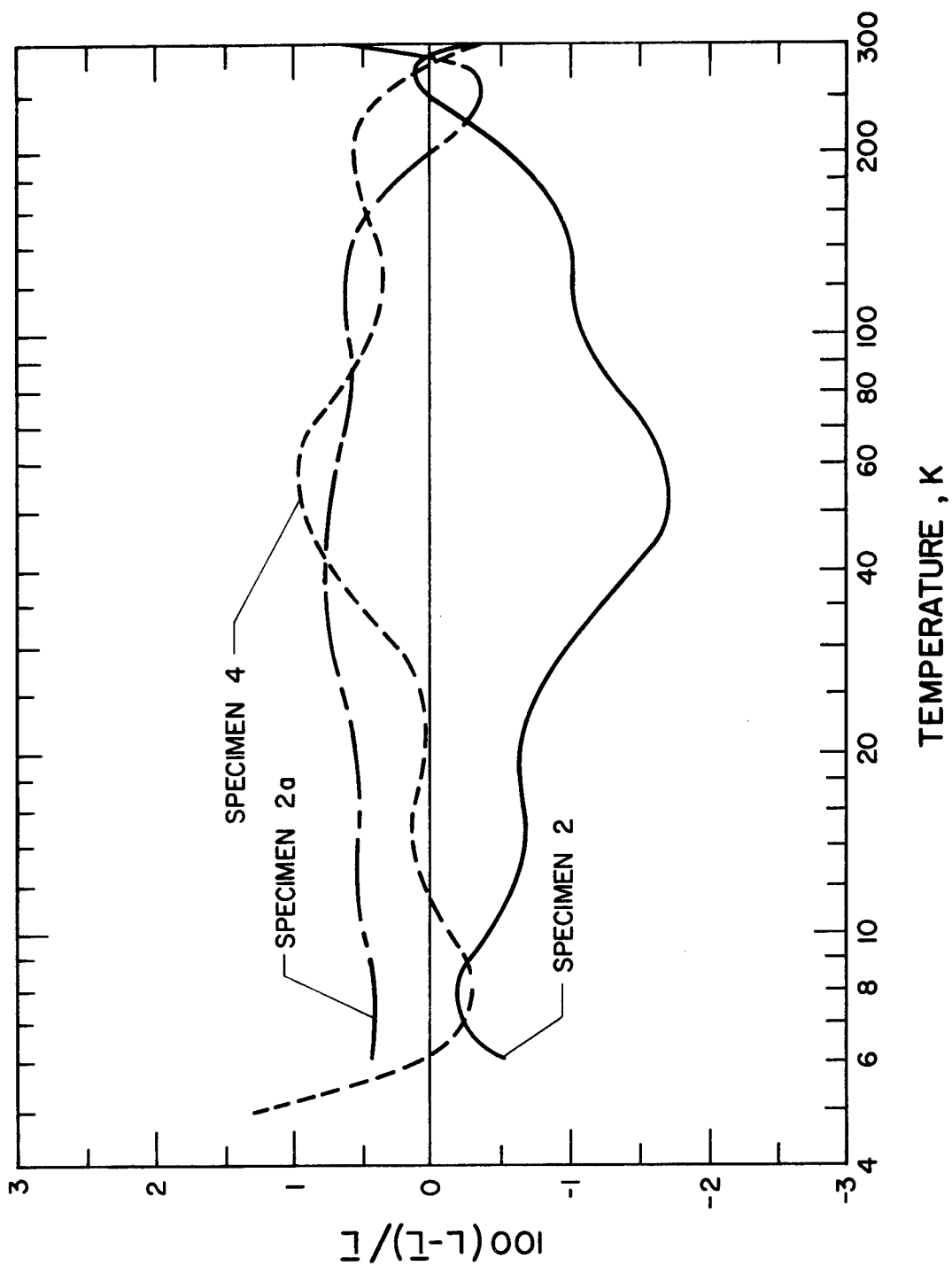


Figure 15. Deviations of the Lorenz ratios of each specimen from the mean values.

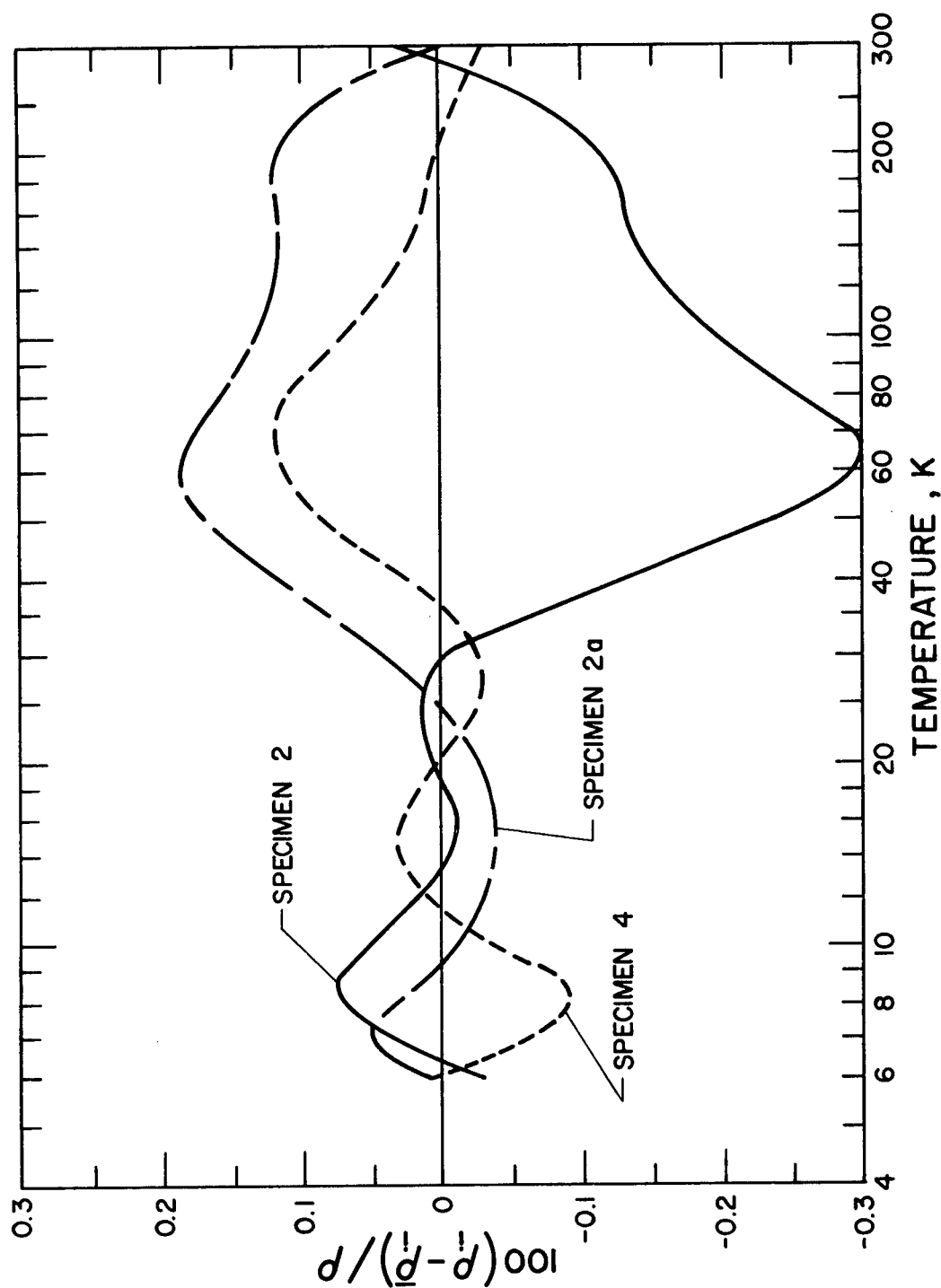


Figure 16. Deviations of the computed intrinsic electrical resistivities from the mean values for the three specimens.

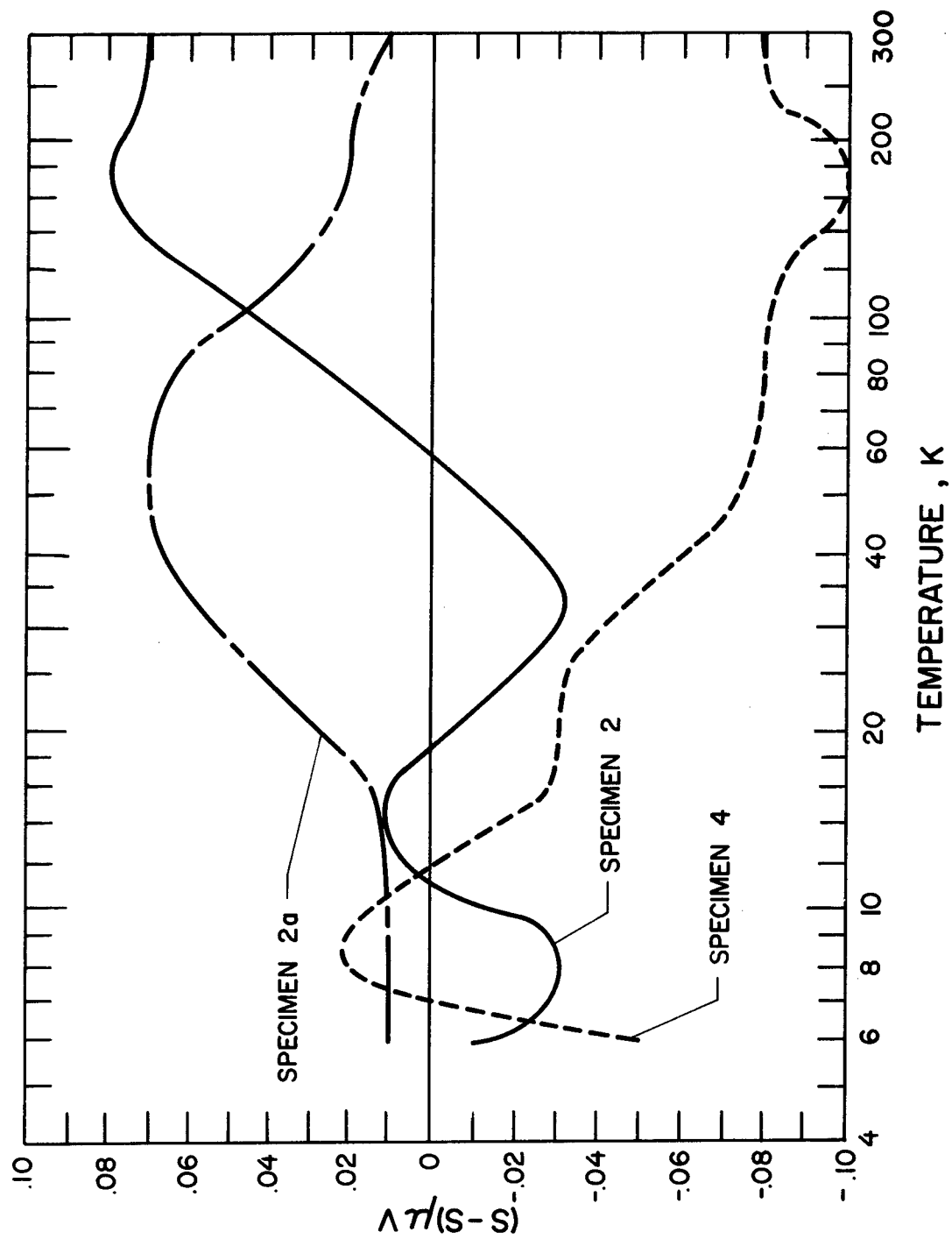


Figure 17. Deviations of the thermopowers from the mean values for three specimens of Armco iron.

8. Appendix

A complete documentation of experimental and numerical procedures was intended to be given in a previous report (Hust, et al.^[1]) so that future manipulations with the experimental data could be performed if necessary. Some useful information, overlooked in the preparation of that report, is included here.

The calibration table for the Chromel vs Au-Fe (Au-0.07 at. % Fe) thermocouples is given in table I. The derivation of this table is explained in reference [1].

To compute the reference ring temperature from the experimental data one needs the calibration of the platinum resistance thermometer. Table II is the calibration table for the PRT used in this apparatus and designated LN-1037903.

To reanalyze any of the reported data one must have the actual thermocouple positions (nominally 2.54 cm apart) and the diameter of the specimen. Table II contains these data for the previously reported specimens as well as for Armco iron.

As reported by Hust, et al.,^[1] zero emfs were read for each thermocouple to eliminate, as much as possible, the effect of spurious emfs in the potentiometric circuitry. These zero emfs differ for each cryogenic bath and are listed in table IV.

Table I - Calibration table for Chromel vs Au-Fe
(Au-0.07 at. % Fe) thermocouple

| T (K) | Emf (μ V) | T (K) | Emf (μ V) |
|----------|-------------------|----------|-------------------|
| | | 51 | 819.32 |
| | | 52 | 836.35 |
| | | 53 | 853.44 |
| 4 | 39.59 | 54 | 870.57 |
| 5 | 52.40 | 55 | 887.74 |
| 6 | 66.07 | 56 | 904.96 |
| 7 | 80.48 | 57 | 922.22 |
| 8 | 95.50 | 58 | 939.53 |
| 9 | 111.03 | 59 | 956.89 |
| 10 | 126.98 | 60 | 974.30 |
| 11 | 143.27 | 61 | 991.75 |
| 12 | 159.83 | 62 | 1009.24 |
| 13 | 176.61 | 63 | 1026.79 |
| 14 | 193.55 | 64 | 1044.38 |
| 15 | 210.61 | 65 | 1062.01 |
| 16 | 227.75 | 66 | 1079.70 |
| 17 | 244.96 | 67 | 1097.42 |
| 18 | 262.19 | 68 | 1115.20 |
| 19 | 279.44 | 69 | 1133.02 |
| 20 | 296.68 | 70 | 1150.88 |
| 21 | 313.90 | 71 | 1168.79 |
| 22 | 331.10 | 72 | 1186.75 |
| 23 | 348.26 | 73 | 1204.74 |
| 24 | 365.38 | 74 | 1222.79 |
| 25 | 382.47 | 75 | 1240.87 |
| 26 | 399.50 | 76 | 1259.00 |
| 27 | 416.50 | 77 | 1277.17 |
| 28 | 433.45 | 78 | 1295.39 |
| 29 | 450.35 | 79 | 1313.65 |
| 30 | 467.22 | 80 | 1331.95 |
| 31 | 484.05 | 81 | 1350.29 |
| 32 | 500.84 | 82 | 1368.67 |
| 33 | 517.61 | 83 | 1387.10 |
| 34 | 534.34 | 84 | 1405.57 |
| 35 | 551.05 | 85 | 1424.08 |
| 36 | 567.74 | 86 | 1442.63 |
| 37 | 584.42 | 87 | 1461.22 |
| 38 | 601.08 | 88 | 1479.85 |
| 39 | 617.74 | 89 | 1498.52 |
| 40 | 634.39 | 90 | 1517.23 |
| 41 | 651.05 | 91 | 1535.98 |
| 42 | 667.73 | 92 | 1554.77 |
| 43 | 684.44 | 93 | 1573.60 |
| 44 | 701.17 | 94 | 1592.46 |
| 45 | 717.94 | 95 | 1611.37 |
| 46 | 734.74 | 96 | 1630.31 |
| 47 | 751.58 | 97 | 1649.29 |
| 48 | 768.45 | 98 | 1668.31 |
| 49 | 785.37 | 99 | 1687.36 |
| 50 | 802.32 | 100 | 1706.45 |

Table I - Calibration table for Chromel vs Au-Fe
(Au-0.07 at. % Fe) thermocouple (Continued)

| T (K) | Emf (μ V) | T (K) | Emf (μ V) |
|----------|-------------------|----------|-------------------|
| 101 | 1725.58 | 151 | 2721.26 |
| 102 | 1744.74 | 152 | 2741.86 |
| 103 | 1763.94 | 153 | 2762.48 |
| 104 | 1783.17 | 154 | 2783.12 |
| 105 | 1802.44 | 155 | 2803.78 |
| 106 | 1821.75 | 156 | 2824.47 |
| 107 | 1841.08 | 157 | 2845.18 |
| 108 | 1860.45 | 158 | 2865.92 |
| 109 | 1879.86 | 159 | 2886.67 |
| 110 | 1899.30 | 160 | 2907.45 |
| 111 | 1918.77 | 161 | 2928.25 |
| 112 | 1938.27 | 162 | 2949.07 |
| 113 | 1957.80 | 163 | 2969.92 |
| 114 | 1977.37 | 164 | 2990.78 |
| 115 | 1996.97 | 165 | 3011.67 |
| 116 | 2016.60 | 166 | 3032.58 |
| 117 | 2036.26 | 167 | 3053.51 |
| 118 | 2055.95 | 168 | 3074.46 |
| 119 | 2075.67 | 169 | 3095.43 |
| 120 | 2095.42 | 170 | 3116.42 |
| 121 | 2115.20 | 171 | 3137.43 |
| 122 | 2135.01 | 172 | 3158.46 |
| 123 | 2154.85 | 173 | 3179.50 |
| 124 | 2174.72 | 174 | 3200.57 |
| 125 | 2194.61 | 175 | 3221.66 |
| 126 | 2214.54 | 176 | 3242.77 |
| 127 | 2234.49 | 177 | 3263.89 |
| 128 | 2254.47 | 178 | 3285.04 |
| 129 | 2274.48 | 179 | 3306.20 |
| 130 | 2294.51 | 180 | 3327.38 |
| 131 | 2314.57 | 181 | 3348.58 |
| 132 | 2334.66 | 182 | 3369.79 |
| 133 | 2354.78 | 183 | 3391.03 |
| 134 | 2374.92 | 184 | 3412.28 |
| 135 | 2395.09 | 185 | 3433.55 |
| 136 | 2415.29 | 186 | 3454.83 |
| 137 | 2435.51 | 187 | 3476.13 |
| 138 | 2455.75 | 188 | 3497.45 |
| 139 | 2476.03 | 189 | 3518.79 |
| 140 | 2496.33 | 190 | 3540.14 |
| 141 | 2516.65 | 191 | 3561.51 |
| 142 | 2537.00 | 192 | 3582.90 |
| 143 | 2557.38 | 193 | 3604.30 |
| 144 | 2577.78 | 194 | 3625.72 |
| 145 | 2598.20 | 195 | 3647.15 |
| 146 | 2618.65 | 196 | 3668.60 |
| 147 | 2639.12 | 197 | 3690.07 |
| 148 | 2659.62 | 198 | 3711.55 |
| 149 | 2680.15 | 199 | 3733.05 |
| 150 | 2700.69 | 200 | 3754.56 |

Table I - Calibration table for Chromel vs Au-Fe
(Au-0.07 at. % Fe) thermocouple (Continued)

| T (K) | Emf (μ V) | T (K) | Emf (μ V) |
|----------|-------------------|----------|-------------------|
| 201 | 3776.09 | 251 | 4869.70 |
| 202 | 3797.64 | 252 | 4891.86 |
| 203 | 3819.20 | 253 | 4914.03 |
| 204 | 3840.77 | 254 | 4936.21 |
| 205 | 3862.36 | 255 | 4958.40 |
| 206 | 3883.97 | 256 | 4980.60 |
| 207 | 3905.59 | 257 | 5002.80 |
| 208 | 3927.22 | 258 | 5025.02 |
| 209 | 3948.87 | 259 | 5047.24 |
| 210 | 3970.54 | 260 | 5069.48 |
| 211 | 3992.22 | 261 | 5091.72 |
| 212 | 4013.91 | 262 | 5113.97 |
| 213 | 4035.62 | 263 | 5136.22 |
| 214 | 4057.34 | 264 | 5158.49 |
| 215 | 4079.08 | 265 | 5180.76 |
| 216 | 4100.83 | 266 | 5203.03 |
| 217 | 4122.60 | 267 | 5225.31 |
| 218 | 4144.38 | 268 | 5247.60 |
| 219 | 4166.17 | 269 | 5269.89 |
| 220 | 4187.97 | 270 | 5292.19 |
| 221 | 4209.79 | 271 | 5314.49 |
| 222 | 4231.62 | 272 | 5336.79 |
| 223 | 4253.47 | 273 | 5359.10 |
| 224 | 4275.32 | 274 | 5381.41 |
| 225 | 4297.19 | 275 | 5403.73 |
| 226 | 4319.08 | 276 | 5426.06 |
| 227 | 4340.97 | 277 | 5448.40 |
| 228 | 4362.88 | 278 | 5470.75 |
| 229 | 4384.79 | 279 | 5493.12 |
| 230 | 4406.72 | 280 | 5515.50 |
| 231 | 4428.66 | 281 | 5537.90 |
| 232 | 4450.62 | 282 | 5560.30 |
| 233 | 4472.58 | 283 | 5582.69 |
| 234 | 4494.55 | 284 | 5605.09 |
| 235 | 4516.54 | 285 | 5627.49 |
| 236 | 4538.53 | 286 | 5649.89 |
| 237 | 4560.54 | 287 | 5672.29 |
| 238 | 4582.56 | 288 | 5694.68 |
| 239 | 4604.58 | 289 | 5717.08 |
| 240 | 4626.62 | 290 | 5739.48 |
| 241 | 4648.67 | 291 | 5761.88 |
| 242 | 4670.73 | 292 | 5784.28 |
| 243 | 4692.80 | 293 | 5806.67 |
| 244 | 4714.87 | 294 | 5829.07 |
| 245 | 4736.96 | 295 | 5851.47 |
| 246 | 4759.06 | 296 | 5873.87 |
| 247 | 4781.17 | 297 | 5896.27 |
| 248 | 4803.29 | 298 | 5918.66 |
| 249 | 4825.42 | 299 | 5941.06 |
| 250 | 4847.56 | 300 | 5963.46 |

Table II - Calibration table for platinum
resistance thermometer designated LN-1037903

| T (K) | R (ohms) | T (K) | R (ohms) |
|----------|-------------|----------|-------------|
| | | 51 | 2.02192 |
| | | 52 | 2.11806 |
| | | 53 | 2.21540 |
| | | 54 | 2.31385 |
| | | 55 | 2.41334 |
| | | 56 | 2.51381 |
| | | 57 | 2.61520 |
| | | 58 | 2.71745 |
| | | 59 | 2.82051 |
| 10 | 0.02343 | 60 | 2.92435 |
| 11 | 0.02636 | 61 | 3.02891 |
| 12 | 0.03008 | 62 | 3.13413 |
| 13 | 0.03479 | 63 | 3.23997 |
| 14 | 0.04071 | 64 | 3.34636 |
| 15 | 0.04806 | 65 | 3.45326 |
| 16 | 0.05705 | 66 | 3.56058 |
| 17 | 0.06786 | 67 | 3.66829 |
| 18 | 0.08067 | 68 | 3.77634 |
| 19 | 0.09568 | 69 | 3.88468 |
| 20 | 0.11305 | 70 | 3.99329 |
| 21 | 0.13294 | 71 | 4.10213 |
| 22 | 0.15548 | 72 | 4.21119 |
| 23 | 0.18082 | 73 | 4.32046 |
| 24 | 0.20905 | 74 | 4.42992 |
| 25 | 0.24025 | 75 | 4.53954 |
| 26 | 0.27448 | 76 | 4.64932 |
| 27 | 0.31178 | 77 | 4.75925 |
| 28 | 0.35218 | 78 | 4.86933 |
| 29 | 0.39566 | 79 | 4.97954 |
| 30 | 0.44224 | 80 | 5.08988 |
| 31 | 0.49192 | 81 | 5.20035 |
| 32 | 0.54466 | 82 | 5.31092 |
| 33 | 0.60042 | 83 | 5.42157 |
| 34 | 0.65915 | 84 | 5.53229 |
| 35 | 0.72078 | 85 | 5.64307 |
| 36 | 0.78522 | 86 | 5.75391 |
| 37 | 0.85236 | 87 | 5.86480 |
| 38 | 0.92213 | 88 | 5.97569 |
| 39 | 0.99441 | 89 | 6.08654 |
| 40 | 1.06909 | 90 | 6.19732 |
| 41 | 1.14607 | 91 | 6.30805 |
| 42 | 1.22526 | 92 | 6.41869 |
| 43 | 1.30656 | 93 | 6.52925 |
| 44 | 1.38988 | 94 | 6.63972 |
| 45 | 1.47513 | 95 | 6.75011 |
| 46 | 1.56222 | 96 | 6.86042 |
| 47 | 1.65106 | 97 | 6.97064 |
| 48 | 1.74153 | 98 | 7.08078 |
| 49 | 1.83356 | 99 | 7.19083 |
| 50 | 1.92706 | 100 | 7.30079 |

Table II - Calibration table for platinum resistance thermometer designated LN-1037903 (Continued)

| T (K) | R (ohms) | T (K) | R (ohms) |
|----------|-------------|----------|-------------|
| 101 | 7.41069 | 151 | 12.81232 |
| 102 | 7.52050 | 152 | 12.91870 |
| 103 | 7.63023 | 153 | 13.02502 |
| 104 | 7.73988 | 154 | 13.13128 |
| 105 | 7.84945 | 155 | 13.23748 |
| 106 | 7.95894 | 156 | 13.34363 |
| 107 | 8.06836 | 157 | 13.44973 |
| 108 | 8.17769 | 158 | 13.55577 |
| 109 | 8.28695 | 159 | 13.66175 |
| 110 | 8.39613 | 160 | 13.76768 |
| 111 | 8.50524 | 161 | 13.87355 |
| 112 | 8.61427 | 162 | 13.97937 |
| 113 | 8.72322 | 163 | 14.08513 |
| 114 | 8.83210 | 164 | 14.19085 |
| 115 | 8.94091 | 165 | 14.29650 |
| 116 | 9.04964 | 166 | 14.40211 |
| 117 | 9.15830 | 167 | 14.50766 |
| 118 | 9.26688 | 168 | 14.61316 |
| 119 | 9.37539 | 169 | 14.71861 |
| 120 | 9.48383 | 170 | 14.82401 |
| 121 | 9.59220 | 171 | 14.92936 |
| 122 | 9.70050 | 172 | 15.03465 |
| 123 | 9.80873 | 173 | 15.13990 |
| 124 | 9.91689 | 174 | 15.24510 |
| 125 | 10.02497 | 175 | 15.35024 |
| 126 | 10.13299 | 176 | 15.45534 |
| 127 | 10.24094 | 177 | 15.56039 |
| 128 | 10.34883 | 178 | 15.66539 |
| 129 | 10.45664 | 179 | 15.77034 |
| 130 | 10.56439 | 180 | 15.87524 |
| 131 | 10.67207 | 181 | 15.98010 |
| 132 | 10.77968 | 182 | 16.08491 |
| 133 | 10.88723 | 183 | 16.18967 |
| 134 | 10.99471 | 184 | 16.29439 |
| 135 | 11.10213 | 185 | 16.39905 |
| 136 | 11.20949 | 186 | 16.50368 |
| 137 | 11.31677 | 187 | 16.60825 |
| 138 | 11.42400 | 188 | 16.71278 |
| 139 | 11.53116 | 189 | 16.81727 |
| 140 | 11.63826 | 190 | 16.92171 |
| 141 | 11.74530 | 191 | 17.02611 |
| 142 | 11.85227 | 192 | 17.13046 |
| 143 | 11.95918 | 193 | 17.23477 |
| 144 | 12.06604 | 194 | 17.33903 |
| 145 | 12.17283 | 195 | 17.44325 |
| 146 | 12.27956 | 196 | 17.54743 |
| 147 | 12.38623 | 197 | 17.65156 |
| 148 | 12.49284 | 198 | 17.75565 |
| 149 | 12.59939 | 199 | 17.85970 |
| 150 | 12.70589 | 200 | 17.96371 |

Table II - Calibration table for platinum resistance thermometer designated LN-1037903 (Continued)

| T (K) | R (ohms) | T (K) | R (ohms) |
|----------|-------------|----------|-------------|
| 201 | 18.06767 | 251 | 23.21758 |
| 202 | 18.17160 | 252 | 23.31969 |
| 203 | 18.27548 | 253 | 23.42178 |
| 204 | 18.37932 | 254 | 23.52383 |
| 205 | 18.48312 | 255 | 23.62585 |
| 206 | 18.58688 | 256 | 23.72784 |
| 207 | 18.69060 | 257 | 23.82980 |
| 208 | 18.79428 | 258 | 23.93172 |
| 209 | 18.89792 | 259 | 24.03362 |
| 210 | 19.00152 | 260 | 24.13548 |
| 211 | 19.10508 | 261 | 24.23732 |
| 212 | 19.20860 | 262 | 24.33912 |
| 213 | 19.31208 | 263 | 24.44089 |
| 214 | 19.41552 | 264 | 24.54263 |
| 215 | 19.51893 | 265 | 24.64435 |
| 216 | 19.62230 | 266 | 24.74603 |
| 217 | 19.72563 | 267 | 24.84768 |
| 218 | 19.82892 | 268 | 24.94930 |
| 219 | 19.93217 | 269 | 25.05088 |
| 220 | 20.03539 | 270 | 25.15245 |
| 221 | 20.13856 | 271 | 25.25397 |
| 222 | 20.24171 | 272 | 25.35547 |
| 223 | 20.34481 | 273 | 25.45694 |
| 224 | 20.44788 | | |
| 225 | 20.55091 | | |
| 226 | 20.65390 | | |
| 227 | 20.75686 | | |
| 228 | 20.85979 | | |
| 229 | 20.96268 | | |
| 230 | 21.06553 | | |
| 231 | 21.16835 | | |
| 232 | 21.27113 | | |
| 233 | 21.37388 | | |
| 234 | 21.47659 | | |
| 235 | 21.57927 | | |
| 236 | 21.68192 | | |
| 237 | 21.78453 | | |
| 238 | 21.88771 | | |
| 239 | 21.98965 | | |
| 240 | 22.09216 | | |
| 241 | 22.19463 | | |
| 242 | 22.29707 | | |
| 243 | 22.39948 | | |
| 244 | 22.50186 | | |
| 245 | 22.60420 | | |
| 246 | 22.70651 | | |
| 247 | 22.80879 | | |
| 248 | 22.91103 | | |
| 249 | 23.01325 | | |
| 250 | 23.11543 | | |

Table III. Thermocouple positions and specimen diameter

Al -7039

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.87540, 1.87550, 2.87560, 3.87540, 4.87570, 5.87560, 6.87560, 7.87580 |
| Specimen diameter (inches) | 0.14499 |

Be

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.86375, 1.86380, 2.86300, 3.86365, 4.86420, 5.86385, 6.86360, 7.86265 |
| Specimen diameter (inches) | 0.14421 |

Hastelloy-X

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.87640, 1.87630, 2.87650, 3.87640, 4.87650, 5.87640, 6.87640, 7.87620 |
| Specimen diameter (inches) | 0.44432 |

Ti A-110 AT

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.87570, 1.87570, 2.87580, 3.87630, 4.87620, 5.87610, 6.87610, 7.87630 |
| Specimen diameter (inches) | 0.44425 |

Inconel 718

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.87580, 1.87580, 2.87680, 3.87590, 4.87710, 5.87710, 6.87740, 7.87740 |
| Specimen diameter (inches) | 0.44380 |

PO-3 graphite

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.87500, 1.87500, 2.87500, 3.87500, 4.87500, 5.87500, 6.87500, 7.87500 |
| Specimen diameter (inches) | 0.42400 |

Armco iron (2c)

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.87520, 1.87560, 2.87580, 3.87620, 4.87490, 5.87550, 6.87540, 7.87560 |
| Specimen diameters (inches)* | 0.14412, 0.14427, 0.14420, 0.14418, 0.14415, 0.14413, 0.14405 |

Armco iron (4c)

| | |
|---|---|
| Thermocouple positions (inches from floating sink) | 0.87720, 1.87700, 2.87740, 3.87750, 4.87690, 5.87770, 6.87780, 7.87760 |
| Specimen diameters (inches)* | 0.14397, 0.14393, 0.14378, 0.14368, 0.14365, 0.14368, 0.14372 |

* These diameters are average values between successive thermocouples starting with the end nearest the floating sink.

Table IV. Zero emfs of specimen temperature measuring thermocouples
(Thermocouple number 1 is nearest the floating sink)

| Cryogenic bath | Zero emf (μV) | | | | | | | |
|-----------------------------|----------------------|------|------|------|------|------|------|------|
| | Thermocouple number | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| liquid helium | 1.22 | 1.01 | 1.05 | 1.17 | 0.94 | 1.01 | 1.15 | 0.91 |
| liquid hydrogen | 0.39 | 0.19 | 0.25 | 0.35 | 0.16 | 0.21 | 0.34 | 0.12 |
| liquid nitrogen | 0.10 | 0.09 | 0.09 | 0.12 | 0.11 | 0.14 | 0.10 | 0.13 |
| alcohol and CO ₂ | 0.00 | 0.12 | 0.08 | 0.09 | 0.12 | 0.12 | 0.09 | 0.14 |
| ice and water | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

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